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ERRATA

Page 58, line 21
for *plalyceros* read *platyceros*

Page 124, line 13
for Wellhausen, E. M. read Wellhausen, E. J.

Explanation of Plate LIII, line 3
for STELIS read STENIA

Page 126, line 21
for *Fourcroea* read *Furcraea*

Page 236, line 9
for inflorercence read inflorescence

Explanation of Plate LVIII, line 1
for *cacavaxochitl* read *cacauaxochitl*

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A NEW NARCOTIC GENUS FROM THE AMAZON SLOPE OF THE COLOMBIAN ANDES

BY

RICHARD EVANS SCHULTES

RECENT ethnobotanical investigations in Colombia have greatly advanced our understanding of the narcotic and stimulant plants which are used in divination, witchcraft and medicine by the Indians of the region. The discovery, in the high and geographically isolated Indian village of Sibundoy, of a dangerously active narcotic tree, representing a new genus belonging apparently to the *Solanaceae*, may have significant consequences in several different fields of study.

In early 1942, whilst I was engaged in ethnobotanical studies in the Putumayo of Colombia, my attention was drawn to a most extraordinary tree which the Kamsá and Inga Indians of the Valley of Sibundoy cultivate for use as a narcotic. Flowering material was collected, an examination of which seemed to indicate that a new genus close to the *Brugmansia* group of *Datura* had been found. In the following years, I made several trips to Sibundoy and was able to gather additional material from the original and several adjacent trees; and colleagues, who have travelled in the area, have been kind enough to prepare specimens from still other trees both in the village of Sibundoy and the neighboring town of Santiago. In

1953, we were able finally to introduce the tree into cultivation in easily accessible gardens. Now, with plentiful material and after more than a decade of cautious consideration, I still hold that we have at hand an undescribed genus, the diagnosis of which is presented herewith.

Methysticodendron *R. E. Schultes gen. nov. Solanacearum.*

Arbor. Folia ligulata. Flores solitarii, maximi, penduli. Calyx longe tubulosus, herbaceus, spathaceus. Corolla profundissime quinquedivisa, lobis spathulatis, acuminatis. Stamina tubi apicem versus affixa, filamentis robustioribus, apicem versus attenuatis et valde contortis; antherae lineares, loculis parallelis introrsum longitudinaliter dehiscentibus. Ovula in quoque loculo numerosa, in placentis axillaria. Styli tres, liberi (sed aspectu singulares, mucilagine (?) cohaerentes, valde tortiles), crassiore filiformi-ligulati sed in sectione concavo-complanati, stigmate indiviso, clavellato-tumescenti; ex ovarii parte centrali duo vel tres appendices, una filiformis, stylo subsimilis sed multo brevior atque una vel duae ad subulas brevissimas vel bullas reductae. Fructus non est praesto.

Genus apparenter *Datura* sectione *Brugmansia* satis affine est.

Generis nomen Graece "arbor somnifica," inter indigenas usum perstringens, significat.

Generis species typica: *Methysticodendron Amesianum.*

Methysticodendron Amesianum *R. E. Schultes spec. nov.*

Arbor usque ad viginti quinque pedes alta, ramulis brevibus, dense foliatis. Folia membranacea, atroviridia, anguste lineari-ligulata, apice acuminata, basi sensim attenuata (saepissime sine petiolo distincto), margine vulgo

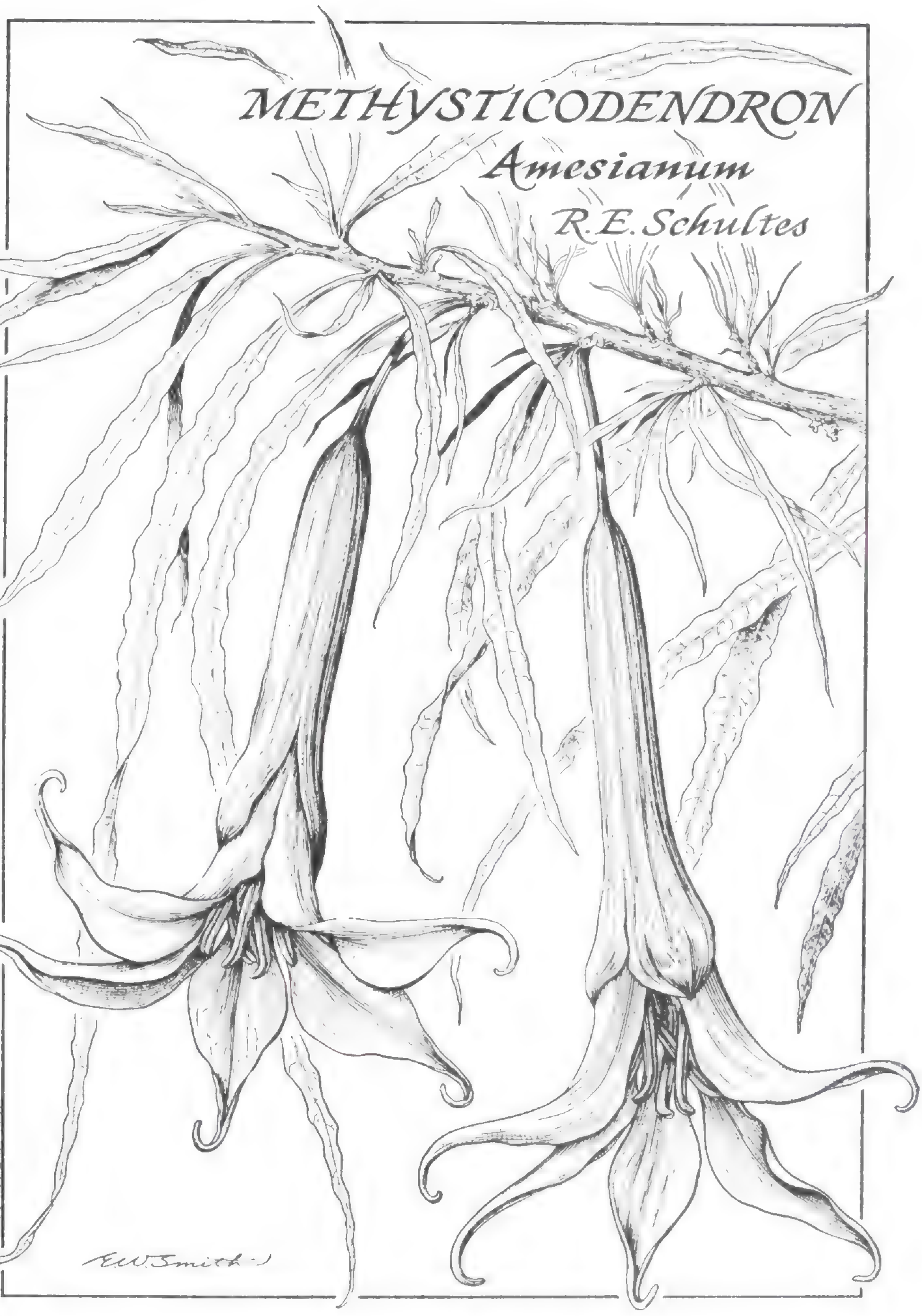
subundulata vel undulata, statu adulto 20–26 cm. longa, 1.3–2.0 cm. lata, nervo centrali robusto, subtus valde elevato, nervis secundariis subparallelis, subconspicuis, marginem versus arcuato-anastomasantibus, utrinque minute et irregulariter (venas versus densiore) pilosa. Flores usque ad 28 (plerumque plusminusve 23) cm. longi, apice in anthesi 10–13 cm. in diametro, solis occasu atque noctu fortissime et dulcissime fragrantes. Calyx spathaceus, viridis, papyraceus vel membranaceus, duo- ad quinquefissus, dentibus acutis, per dimidium tubiformis, 3/5 corollae longitudine (usque ad 13 cm. longus), utrinque minutissime et irregulariter pilosiusculus. Corolla 3/5–4/5 pro parte divisa, lobis saepissime quinque (sed abnormaliter quattuor vel sex), membranaceis, albis, patentibus, spathulatis vel subspathulate rhombiformibus, apice longe acuminatis, cincinnalibus, margine integris, dimidio superiore valde inflexis, 14–16 cm. longis, tubi apicem versus plerumque 6 mm. sed in parte latiore 2.5–3.3 cm. latis, basim versus utrinque remotissime et irregulariter pilosiusculis, tribus cum venis conspicuis, valde parallelis; tubus intus densiore albido-pilosus. Stamina saepissime quinque, corollae lobis breviora, filamentis teretibus, plusminusve 5 cm. longis, basi 2 mm. in diametro, apice valde contortis atque leviter tortilibus, apice excepto pilosiusculis, antheris flavis, 2.7–3 cm. longis, 3–4 mm. in diametro. Ovarium subcylindricum, conspicue trisulcatum, glabrum, usque ad 1.5 cm. longum, 0.5 cm. in diametro, in stylos sensim productum. Styli glabri, usque ad plusminusve 9 cm. longi, 2.5 mm. in diametro, apice paulo clavellati et valde complanati, stigmatis textu in apice ipso et in marginibus usque ad 1–1.5 cm. decurrenti, nigro (siccitate) et papilloso. Appendix (stylus incohatus ?) ex ovarii parte centrali stylis similis, usque ad 5.5 cm. longa, ab una vel duabus appendicibus subclavellatis carnosis, 2–5 mm. longis comitata.

EXPLANATION OF THE ILLUSTRATION

PLATE I. METHYSTICODENDRON AMESIANUM *R. E. Schultes.* Habit drawing of a flowering branch, about one half natural size.

Drawn by ELMER W. SMITH

Plate I

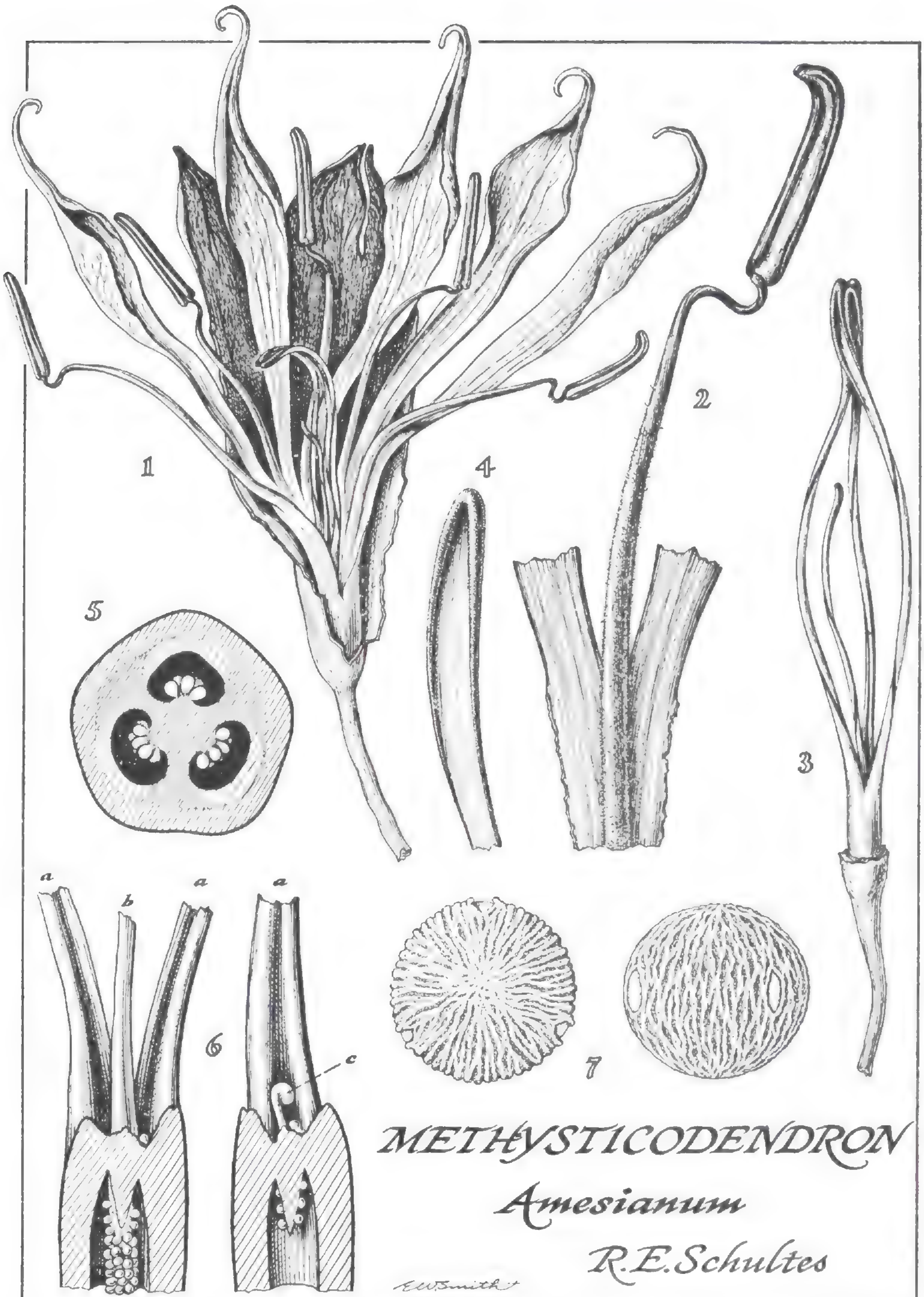


EXPLANATION OF THE ILLUSTRATION

PLATE II. METHYSTICODENDRON AMESIANUM *R. E. Schultes*. 1, partly dissected flower, about one half natural size, showing the relative sizes of stamens, styles and other floral segments. 2, a stamen and its attachment, slightly more than natural size. 3, the styles and the style-like appendage, about three quarters natural size. 4, the tip of a style showing the stigmatic surface, about three times natural size. 5, cross section of the ovary, about six times natural size. 6, sagittal section of the apical part of the ovary showing (a) styles, (b) the large appendage homologous with the styles and (c) one of the minute appendages arising from the central tissue of the ovary, about three times natural size. 7, pollen grains, about four hundred and fifty times natural size.

Drawn by ELMER W. SMITH

PLATE II



METHYSTICODENDRON
Amesianum
R.E.Schultes

E.W.Smith del

EXPLANATION OF THE ILLUSTRATION

PLATE III. Habit photograph of the plant from which the type of *Methysticodendron Amesianum* was taken. Sibundoy, Colombia.

Photograph by RICHARD EVANS SCHULTES

Plate III

EXPLANATION OF THE ILLUSTRATION

PLATE IV. Kamsá Indian boy holding a flower of *Methysticodendron Amesianum*. Sibundoy, Colombia. *Photograph by* RICHARD EVANS SCHULTES

Plate IV

Specei nomen professorem rerum herbarum demortuum Oakes Ames Universitatis Harvardianae, quis studia mea plantarum somnificarum inter indigenas americanos excitavit, honorat.

Methysticodendron is here described as a genus of the *Solanaceae* with some hesitation, for the concept shows several characters which are not easily accommodated in that family.

In habit, *Methysticodendron Amesianum* is a small tree quite suggestive of some of the larger tree-species of *Datura*, i.e., *D. arborea* L., *D. suaveolens* HBK. and *D. Rosei* Safford. Like these members of the *Brugmansia* section of *Datura*, the new concept is characterized by large, pendulous flowers. The intoxication which a decoction of the leaves of *Methysticodendron Amesianum* induces bespeaks the presence of similar alkaloids: hyoscyamine and scopolamine. There are also strong similarities in the branching, as well as in the structure of the calyx and stamens.

The pollen grains of the type plant of *Methysticodendron* have been studied by Dr. Thomas van der Hamen, palynologist to the Servicio Geológico Nacional of Colombia and by Professor Elso S. Barghoorn of the Botanical Museum of Harvard University. Dr. Barghoorn's description of the grains follows:

Pollen grains spherical, chiefly inaperturate, occasionally tricolporate or triporate with very weakly developed short furrows. Size ranging from 45μ to 63μ, averaging about 53μ (after acetylation). Sculpturing of the exine striate, and of the "finger print" pattern of striation. Striae converging at the poles and commonly anastomising between the poles. Polar areas reticulate-foveolate. A feeble punctate or reticulate texture may be detected between the striae or along their sides. Equatorial costae conspicuous.

In basic morphology the grains are a modified bipolar, tricolpate type, in which both pores and furrows have been greatly reduced.

The pollen grains of *Methysticodendron* are of the same type and are, indeed, very similar to the grains of other species of *Datura*, section *Brugmansia*.

Notwithstanding these similarities, *Methysticodendron* can be distinguished at once from the tree-species of *Datura* by its very deeply lobose corolla which is divided for three-fifths to four-fifths of its length. The tubular portion of the corolla is wholly enclosed within the tubular, spathaceous calyx, so that it bears a superficial resemblance to a polypetalous flower, the gamopetalous condition not being evident as the blossoms hang on the tree. The narrowly ligulate leaves are also strikingly unlike those of the tree-species of *Datura*.

The major and perhaps fundamental departure from the solanaceous condition, however, lies in the morphology of the ovary and styles. *Methysticodendron* has three conduplicate carpels with three free styles (with undivided stigmatic areas) which retain the conduplicate condition. The concave structure of the styles leaves the ovule cavity somewhat open at the apex, exposing the apical ovules, until, about one third of the way down, the carpel walls fuse to form a trilocular syncarp. All members of the *Solanaceae* have a simple style with a two-lobed stigma. All members of the tribe *Datureae* have a four-celled ovary. Indeed, the only tribe of the family possessing a three- to five-celled ovary is the *Nicandreae*, but even *Nicandra* has a simple style.

The structures most difficult of interpretation are the several appendages arising from the central tissue of the ovary. One of these is an elongated appendage usually entirely homologous with the styles (even to the presence of what appears to be stigmatic tissue), but much shorter. Accompanying this appendage are usually one or two anomalous knob-shaped, clavate or even subulate projections. These do not appear to arise consistently

from any definite part of the ovary. They resemble adventitious style-like outgrowths.

Several fruits of *Methysticodendron Amesianum* were collected in 1947. These were preserved in alcohol and sent to Bogotá, but, unfortunately, they were lost in shipment. Consequently, a detailed description of them cannot be given here. We may record, however, that they were unarmed, smooth, indehiscent and fusiform, about six inches in length and in shape very like the fruit of *Datura suaveolens*.

The evidence for retaining *Methysticodendron* in the *Solanaceae* seems to me to be overwhelming. Nevertheless, the several fundamental characters in which this concept diverges from the conditions now embraced by the family must be borne in mind. It would seem entirely probable that a new tribe should be set up within the *Solanaceae* to accommodate *Methysticodendron*.

Would we not be warranted in suspecting that we have at hand perhaps a primitive representative of the *Solanaceae*, possibly a prototype of what has today developed into the tree-species of *Datura?* The apparent primitiveness in the union of floral parts might conceivably be interpreted in this light. In any consideration that *Methysticodendron* may represent a prototype of the modern representatives of the brugmansioid *Datura*-species, it would be advisable to take into account the interesting fact that the Valley of Sibundoy, a locality which we know to be a repository of many curious endemics, is a high Andean region, and the center of origin of some tree-species of *Datura* is thought to be the northern Andean area.

Because of the extreme rarity of this plant, even in the Valley of Sibundoy, and because of its extraordinary beauty, several attempts were made to introduce *Methysticodendron Amesianum* into cultivation. In 1953, efforts

to establish it by planting short sticks cut from the upper branches met with success. The species is now in cultivation in the Capuchin Mission Station at Sibundoy; in the gardens of the Ciudad Universitaria in Bogotá, Colombia; in the Universidad del Cauca, Popayán, Colombia; at the Royal Botanic Gardens, Kew; in the greenhouses of the Department of Biology, Harvard University; and at the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Beltsville, Maryland.

Methysticodendron Amesianum, known only from the Valley of Sibundoy, is there employed by the Inga and Kamsá Indians in their witchcraft. Its use in each tribe is restricted to several witch-doctors, and these practitioners grow the plant with special care in the neighborhood of their huts. The wild habitat of the species is said to be the forested slopes of the mountains to the south of the Valley of Sibundoy, especially the slopes of the botanically almost completely unknown Cerro Patascoy. When in cultivation, the plant is apparently the hereditary property of certain families, forasmuch as the sorcerers pass it on to the eldest son together with the secrets attending its use.

Little could be learned about the use of the narcotic, partly because of the proximity of influential Christian missionaries. It would appear from what information I have been able to glean that *Methysticodendron Amesianum*, which the Indians classify together with other intoxicating solanaceous plants similarly used, is by far the strongest of all the narcotics of the region, surpassing in danger and potency even *Datura arborea*. A description of the intoxication leaves no doubt that the active principles are solanaceous alkaloids of the tropane series. This intoxication, resorted to by the witch-doctors only for very important or difficult cases of divination, prophecy

or therapy, usually lasts for two full days and sometimes may persist for four—with a long period of complete lack of consciousness. Missionaries who have been at work in the Valley of Sibundoy for more than a quarter of a century suspect that the death of one aged witch-doctor may have been due to an overdraught of this narcotic.

Smaller doses of the drug are administered to boys who are studying witchcraft. Certain of the medicine-men's secrets apparently are imparted only when the novitiate is "under the protection" of this narcotic.

According to the sparse information available, only the leaves of *Methysticodendron Amesianum* can be employed in the preparation of the narcotic infusion. The leaves, which must be gathered not more than one hour before the narcotic drink is to be taken, are stripped from the plant, crushed and allowed to remain in cold water for perhaps one half hour. Just before the draught is to be taken, the leaves and the infusion are slightly heated and agitated. Then the liquid is strained. It is, apparently, never allowed to boil.

Witch-doctors never take the whole draught at one time, it is said; but they may drink as much as a large cup-full over a period of two or three hours. If, by then, the desired frenzy and initial narcosis have not been induced, an assistant prepares additional drink from fresh leaves.

According to the Indian tradition, this narcotic must be taken only during the wane of the moon.

In addition to its use in divination and prophecy, *Methysticodendron Amesianum* is employed by its "owners" in the treatment of certain diseases. The leaves and flowers are heated in water and applied in the form of a plaster for the reduction of tumors and swellings, especially of the joints. For persistent chills and fevers (advanced tuberculosis (?)), which are not uncom-

mon at this high, damp altitude, the witch-doctor will sometimes first bathe the whole body of a patient with a warm decoction of the leaves and flowers, then smear lamb-fat on the chest, back and abdomen.

The Kamsá name of *Methysticodendron*, *mets-kwai borrachero* or *mits-kway borrachero*, means "intoxicant of the jaguar." The term *borrachero* is a loan-word from Spanish, for in southern Colombia and Ecuador a large number of solanaceous narcotics are referred to popularly as *borrachero* (*borracho* = drunken). Notwithstanding the meaning of the Kamsá *mets-kwai*, these Indians refer to the plant in Spanish as *culebra-borrachero* ("intoxicant of the snake") and not as *tigre-borrachero*. Another name which the Kamsá people apply to the plant is *goon'-ssi-an borrachero*, the meaning of which I could never ascertain. The Inga Indians of the Valley of Sibundoy call the plant *kin-de-borrachero*.

I wish to acknowledge gratefully the helpful suggestions of many of my colleagues at Harvard University and elsewhere during my study of the material of *Methysticodendron Amesianum*. My special appreciation to Professor Irving W. Bailey and to Professor Ivan M. Johnston is here expressed. The plates which Mr. Elmer W. Smith has so painstakingly prepared were made possible by a grant from the American Academy of Arts and Sciences.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, Sibundoy, alt. 2225 m. "Treelet 25 feet tall. Cultivated in Indian garden. Used as divinatory narcotic. Flowers white, anthers yellow. *Culebra borrachera*. Kamsá = *mits-kway borrachera*." June 30, 1953, *Richard Evans Schultes & Isidoro Cabrera 20079* (TYPE in Herb. Gray).—Comisaría del Putumayo, Sibundoy, alt. about 6700 feet. "Treelet 25 feet tall. Flowers pendulous, white. Leaves used to prepare a narcotic drink for use of witch-doctors in divination. Spanish: *culebra borrachera*. Ingano = *kin-de borrachero*. Kamsá = *goon-ssi-an borrachero*." February 16, 1942, *Richard Evans Schultes 3256*.—Comisaría del Putumayo, Sibundoy, Valle de Sibundoy. "In garden near house of an Indian

herb doctor. Erect shrub 3–4 m. tall. Flowers white, somewhat irregular. Plant apparently sterile, as old flowers seem to drop off, and the people say it never sets fruit. *Culebra borrachero* planted here not seen wild.'' March 30, 1943. *F. R. Fosberg 20406.*—Comisaría del Putumayo, al norte de Sibundoy, alt. 2250 m. ''Arbusto de 3 m. Flores blancas. Estambres color gris, anteras amarillas.'' February 21, 1951, *Mardoqueo Villarreal 68.*—Comisaría del Putumayo, al sur de Sibundoy, alt. 2250 m. ''Inga = *boracero.* Kamsá = *nitwaí-boracero.* Arbusto 2 a 3 m. Flores muy jovenes, color verde-claro; adultas blancas.'' February 22, 1951, *Mardoqueo Villarreal 71.*—Comisaría del Putumayo, al sur de Sibundoy, alt. 2250 m. ''Arbusto de 3 m. Flores blancas.'' February 22, 1951, *Mardoqueo Villarreal 72.*—Comisaría del Putumayo, al sur de Sibundoy, alt. 2250 m. ''Arbusto de 3 m. Flores jovenes, color verde-claro; adultas blanco-pálidas.'' February 22, 1951, *Mardoqueo Villarreal 73.*—Comisaría del Putumayo, al sur de Sibundoy, alt. 2250 m. ''Arbusto de 3 m. Flores muy jovenes, color verde-claro; adultas blanco-palidas. Ingano = *culebra borrachero;* Kamsá = *nitkwai boracero.*'' February 22, 1951, *Mardoqueo Villarreal 74.*—Comisaría del Putumayo, camino de Santiago a San Andrés, cerca al Río Quinchoa, alt. 2270 m. ''Ingano = *culebra borrachera.* Árbol de 3 m. Corolo blanco-pálida. Estambres blanco-verdosos; anteras carmelitas.'' February 24, 1951, *Mardoqueo Villarreal 94.*—Comisaría del Putumayo, camino de Santiago a San Andrés, cerca al Río Quinchoa, La Misión, alt. 2270 m. ''Kamsá = *quinchora borrachero.* Arbusto de 2 a 3 m. Flores blancas. Estambres ligamente blanco-violáceas; anteras semi-violáceas.'' February 24, 1951, *Mardoqueo Villarreal 95.*—Comisaría del Putumayo, Valle de Sibundoy, Santiago, alt. ca. 2250 m. ''*Culebra borrachero.* Arbolito ramoso 2–3 m. de alto. Flores blancas. El líquido resultante por la decocción de las hojas lo toman los indígenas para alucinarse.'' September 22, 1953, *A. Fernández 2641.*

PITCH-YIELDING TREES OF THE COLOMBIAN AMAZONIA

BY

RICHARD EVANS SCHULTES

WHILE in the northwest Amazon, I was repeatedly impressed by the important role which various resinous pitches play in the daily lives of the Indians of the area. A study of some of the trees which are most commonly used as sources of pitch has not only yielded interesting ethnobotanical data but has also brought to light several apparently hitherto undescribed specific and varietal concepts.

Sundry resiniferous plants are used by the Indians of the northwest Amazon for domestic purposes. Important amongst these plants are *Couma macrocarpa* Barb.-Rodr. of the *Apocynaceae* (the resin of which is extensively employed in caulking canoes), *Protium heptaphyllum* L. of the *Proteaceae* (the brittle and aromatic resin of which is sometimes added to clay for making pots) and several species of *Manilkara* and *Ecclinusa* of the *Sapotaceae*.

Notwithstanding the utilization of these and other plants, attention in this paper will be directed principally to three closely allied genera of the tribe *Moronobeae* of the *Guttiferae*: *Moronobea*, *Platonia* and *Symphonia*. Field studies have indicated that trees of these genera are, for most domestic uses, preferred by the natives of the northwest Amazon over all other species which yield

pitch. A review of the literature indicates that the slight amount of attention which these genera have received is hardly commensurate with their economic importance to human life in the Amazon forests. Since the latexes of all three of these genera are similar in consistency and uses (in some cases having the same native name), they are treated here together. It appears, nevertheless, that the several species of *Symphonia* are the most important pitch-plants amongst the Indians of Amazonian Colombia.

Moronobea coccinea *Aublet* Hist. Pl. Guy. Fran. (1775) 788, t. 313 excl. figs. a–f.

Aublet, in describing *Moronobea coccinea* in 1775 ("Histoire des Plantes de la Guyane Française" (1775) 792), stated that the Caribs ("Galibis") utilized the resin of the tree to glue on the points and poisonous teeth of their arrows. The tree as well as its resin was called *mani* in French Guiana. The common name *mani* is likewise employed for the pitch of *Moronobea coccinea* in Surinam (van Cappelle, H.: "Au travers des forêts vièrges de la Guayane Hollandaise" (1905) 26).

Working in the upper Orinoco basin in Venezuela at the turn of the 18th century, Humboldt (Humboldt, A.: "Personal narratives of travels to the equinoctial regions of America" 2 (1900) 357) found the extraction of resin from *Moronobea coccinea* to be a flourishing industry at Javita, a small town on the Río Temi (an affluent of the Río Atabapo). He wrote:

> . . . In the forests of those burning climates (where there is neither pine, thuya, taxodium, nor even a podocarpus), resins, balsams and aromatic gums are furnished by the *Moronobea*, the icica and the amyris. The collecting of these gummy and resinous substances is a trade in the village of Javita. The most celebrated resin bears the name of *mani;* and of this we saw masses of several hundred-weight, resembling colophony and mastic. The tree called *mani* by the Paraginis, which M. Bonpland believes to be the *Moronobea coccinea*, furnishes but a

small quantity of the substance employed in the trade with Angostura. The greatest part comes from the *mararo* or *caragna*, which is an amyris. It is remarkable enough that the name *mani*, which Aublet heard among the Galibis [Caribs] of Cayenne, was again heard by us at Javita, three hundred leagues distant from French Guiana. The *Moronobea* or *Symphonia* of Javita yields a yellow resin; the *caragna*, a resin strongly odoriferous and white as snow; the latter becomes yellow where it is adherent to the internal part of the old bark.

At the hamlet of Pimichín, near Javita, Humboldt spent the night at a pitch-gatherers' camp (*loc. cit.* 368) and was able personally to see evidence of this forest industry:

> We passed the night in a hut lately abandoned by an Indian family . . . A great store of *mani* (a mixture of the resin of the *Moronobea* and the *Amyris Caraña*) was accumulated around the house. This is used by the Indians here, as at Cayenne, to pitch their canoes and fix the bony spine of the ray at the points of their arrows.

The Kubeo and Desano Indians along the Río Vaupés and its Colombian affluents gather quantities of the pitch from *Moronobea coccinea* (which seems to be much more abundant from Mitú downstream than in the headwaters of the river) for making huge torches for the lighting of their large communal houses during tribal dances. Compact lumps of the dried, blackened pitch are heated and applied to the tops of small posts driven into the earthen floor. When ignited, the pitch gives off a surprisingly bright light. The Tanimukas and Yukunas sometimes employ the pitch of this species in the manufacture of dancing-masks, but the preferred resin for this purpose is that from *Symphonia*.

Colombia: Comisaría del Amazonas, Trapecio Amazónico, interior regions of trapecio between Amazon and Putumayo watersheds. Alt. above 100 m. November 1946, *George A. Black & Richard Evans Schultes 46-369.*—Comisaría del Vaupés, Río Vaupés, Mitú and vicinity. Alt. about 250 m. "Columnar tree, 1½ feet in diameter. Height 90 feet. Crown sparse, all at top. Bark thick, soft, roughish, brown outside, sandy inside. Latex abundant, yellow. Wood yellowish white. Flowers rose-red. Tukano = *woo-há-pee-ka-ne;* Taiwano = *go-hé.*" Septem-

ber 8, 1951, *Richard Evans Schultes & Isidoro Cabrera 13960.*—Comisaría del Amazonas, Río Caquetá, La Pedrera and vicinity, Quebrada Tonina. "Large tree. Yukuna = *koo-peé;* Kuripako = *koo-á-see;* Kabuyarí = *maú-pa;* Puinave = *boo-kwan;* Tanimuka = *ree-ká-wa-ree-ka.*" October 5, 1952, *Schultes & Cabrera 17728.*

Moronobea riparia (*Spruce*) *Planchon & Triana* var. **fimbrillata** *R. E. Schultes var. nov.*

Arbor usque ad sexaginta pedes alta, riparia, a *Moronobea riparia* pedicellis multo crassioribus et longioribus, petalis apicem versus conspicue fimbrillatis (non integris), albido-viridibus (non albis) atque latice laete flavo (non viridi) principaliter differt.

The type of *Moronobea riparia* was collected by Spruce along the Río Casiquiare and its affluents in Venezuela, not far from the locality of the three Colombian collections cited below.

An examination of a duplicate type of *Moronobea riparia* (*Spruce 3350*) in the Gray Herbarium shows that the petals do not have the fimbrillate margin near the apex, which is very conspicuous in the Colombian collections upon which I am basing this new variety. This fimbrillate margin, together with the general tendency for the petals to be somewhat greenish and the bright yellow latex, would seem to indicate that we have at hand a geographic variant which is best treated as a variety.

The otherwise excellent drawing of *Moronobea riparia* in Martius' *Flora Brasiliensis* 12, pt. 1 (1886) t. 106 errs in depicting for this species acute petals. The petals in the Gray Herbarium specimen of *Spruce 3350* are broadly rounded, albeit, in aestivation, the imbricate condition of the bud gives the superficial impression of acute petals.

Like that of other species of the genus, the latex of *Moronobea riparia* var. *fimbrillata* is employed for various household uses by the Indians along the Río Guainía.

Because of its very rugose bark, however, it is harder to bleed than *Moronobea coccinea*.

Colombia: Comisaría del Vaupés, Río Guainía, Puerto Colombia and vicinity (opposite Venezuelan town of Maroa). Alt. about 800–850 feet. General location: Lat. 2°40′ N, Long. 67°30′ W. "Flowers greenish white. Stigma and pistil bright green. Latex bright yellow. Bark thick, scaly, dark brown, corky. Tree storied. Height 40 feet. Diameter 14 inches. Kuripako = *ma-rá-ke*. Spanish = *brea*. Geral = *i-rai-kee*." October 31–November 2, 1952, *Richard Evans Schultes, Richard E. D. Baker & Isidoro Cabrera 18206* (Type in Herb. Gray).—Same vicinity and date. "Tree with storied branches. Height 60 feet. Latex yellow. Flowers greenish white. Stigmas bright green. Diameter 18 inches. Bark rough, shaggy, very dark brown. Puinave = *möm*." *Schultes, Baker & Cabrera 18210*.—Same vicinity and date. Raudal del Sapo. "Tree, 45 feet tall. Branches storied. Latex yellow. Bark thick, corky, shaggy, dark brown. Flowers white, petals slightly green-tinged. Pistil bright green." *Schultes, Baker & Cabrera 18221*

Moronobea riparia (*Spruce*) *Planchon & Triana* var. **piraparanensis** *R. E. Schultes var. nov.*

Arbor viginti quinque pedes alta, riparia, a *Moronobea riparia* foliis majoribus, apice subacutis (nec late rotundatis nec conspicue indentatis) atque floribus majoribus (petalis obliquuo-orbicularibus, 7 cm. × 7 cm.) principaliter differt.

This new variety, like *Moronobea riparia* itself, is conspicuous in the genus in having a curious greenish or greenish yellow latex.

The collection *Schultes & Cabrera 17147* is sufficiently distinct in its leaf and petal characters to warrant varietal recognition. Along the creeks and brooks emptying into the middle course of the Río Piraparaná, *Moronobea riparia* var. *piraparanensis* is rather abundant. The Barasana and Makuna Indians of the region employ the latex for making torches and for caulking canoes.

Colombia: Comisaría del Vaupés, Río Piraparaná, Caño Oomooña. "Small tree on waterside. Height 25 feet. Flowers white, stigma green. Latex greenish yellow. Makuna = *gö-hé-gö*; Barasana = *ö-fé-gö;*

Puinave = *koo-an.*'' September 3, 1952, *Richard Evans Schultes & Isidoro Cabrera 17147* (TYPE in Herb. Gray).

Moronobea rupicola *R. E. Schultes sp. nov.*

Arbor mediocris, usque ad duodecim pedes alta. Truncus aliquid contortus, 8 poll. in diametro, cortice molli, fusco rimosoque, latice copioso, flavo. Ramuli cortice rufo-fusco densissime foliosi, internodiis plusminusve 8 cm. longis. Folia firme subcoriacea, supra nitida atroviridiaque, infra pallidiora, breviter petiolata (petiolis 6–10 mm. longis, aliquid complanatis), obovata, apice brevissime et abrupte acuminata, basi cuneata, margine leviter marginata, usque ad 8–8.5 cm. longa, 4 cm. lata, nervis lateralibus 0.7 1 mm. inter se distantibus. Flores terminales, citrini sed petala basim versus pallide rosea. Pedicelli brevissimi 4-6 mm. longi, crassi, rosei. Sepala valde inaequalia, crasse chartacea; duo exteriora orbiculata, margine integra, conspicue rugulosa, plusminusve 5 mm. longa, 7 mm. lata; interiora similia sed majora, 8 mm. longa, 10–12 mm. lata. Petala cucullata, extus subvelutina, obliquuo-ovata, apice rotundata vel saepe subacuta, margine integra, 3.5–4 cm. longa, 3.5 cm. lata. Discus infrastamineus annularis, inter staminum adelphias in lobulos sanguineos carnosulos tumens. Synandrium plusminusve 2.5 cm. longum, contortum, phalangibus plerumque 3-andris. Ovarium glabrum, obscure sculptum, oblongo-ovoideum, 1.5 cm. longum. Stylus 1.5 cm. longus, in brachia 1–1.5 mm. longa exiens, ultra petala non exsertus. Fructus adhuc ignotus.

Moronobea rupicola appears to be most closely allied to *M. ptaritepuiana* Steyerm., native to Cerro Ptaritepuí in Venezuela, the flora of which has many elements in common with that of Cerro Isibukuri. The former species can be distinguished from the latter at once by its abruptly acuminate (instead of apically rounded)

leaves which are larger, by having three (instead of five) anthers in each staminal bundle, by its much shorter pedicels and by its lemon-yellow and basally pink (instead of greenish white and apically pink) petals.

The bright yellow latex of *Moronobea rupicola* is utilized by the Kabuyarí and Taiwano Indians of the Río Kananarí for making slow-burning torches, which are the source of light at festivals and dances in large communal houses.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. Alt. 250–700 m. "Tree 35–40 feet tall. Diameter 8 inches. Latex yellow. Flowers yellow, base of outer part of petals slightly pink-tinged. Half way up the mountain." August 4, 1951, *Richard Evans Schultes & Isidoro Cabrera 13384* (TYPE in Herb. Gray).—Same locality. "Flowers yellow." October 29, 1951, *Schultes & Cabrera 14525.*

Platonia insignis *Martius* var. **formosa** *R. E. Schultes var. nov.*

Arbor enormis, usque ad 90 ped. alta, trunco usque ad 1 m. in diametro, a *Platonia insignis* petalorum parte exposita margine auri usu valdissime revoluta, styli brachiis multo longioribus atque sepalis vulgo minoribus principaliter differt.

It might seem that the differences upon which *Platonia insignis* var. *formosa* are based are trivial. The peculiar folding back of the exposed parts of the imbricated petals, however, is so conspicuous that it lends the flowers a very distinctive appearance. There is occasionally some slight folding back of the petals in *Platonia insignis*, but an examination of ample material from Brazil, the Guianas and Venezuela and a study of the description and drawing in Martius' *Flora Brasiliensis* convince me that usually the petals are not at all revolute and that, in those few cases where they are, this condition is slight and wholly confined to the very margin. In the variety here described, the folding back is, as I have

stated in the diagnosis, "in the manner of an ear," the rolled-back portion measuring from 5 to 8 mm. in width from the edge, in material preserved in alcohol.

The fruit of *Platonia insignis* var. *formosa* is a large, fleshy, edible bacca. It is a favorite food of the Indians in season and, for this reason, the tree is always spared when new plots are being cleared for agriculture. The extraordinarily abundant, thick, yellow resin is employed in much the same ways as the resinous latexes of *Moronobea* and *Symphonia*.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná (tributary of Río Apaporis), Raudal Guá-kö-nö-ta. General location: Between Lat. 0°15′ S, Long. 70°50′ W and Lat. 0°25′ N, Long. 70°30′ W. "Flowers rose-red. On sand at river's edge. Latex yellow. Stamens bright yellow. Makuna = *gö-hé-ree-ka;* Puinave = *kö.*" September 4, 1952, *Richard Evans Schultes & Isidoro Cabrera 17168* (TYPE in Herb. Gray). —Same locality, Raudal de la Olla. "Tree 25 m. Columnar. Bark grey-brown, rough with scales. Flowers salmon-pink. Petals curl out at edge. Receptacle thick, same colour. Latex cream-coloured. On rocks at falls. Crown not large. Tanimuka = *oo-ká-o-ree-ke;* Yukuna = *he-pé-la.*" August 28, 1952, *Schultes & Cabrera 17062.*—Same locality, Raudal Koro. "Same as *17062*, but flowers lighter salmon and wings of petals pale violet. Latex yellow. Tall tree." August 30, 1952, *Schultes & Cabrera 17089.*—Comisaría del Vaupés, Río Vaupés, between Mitú and Javareté, Araracachivera. "Low tree. Latex yellow. Flowers salmon-pink. Pedicel fleshy." May 14–24, 1953, *Schultes & Cabrera 19395.*

Symphonia globulifera *Linnaeus fil.* Suppl. (1781) 302.

Im Thurn, the explorer of British Guiana, reported (Holland, J. H.: "The useful plants of Nigeria" in Kew Bull. ad. ser. 9, pt. 1 (1908) 62) that a wax prepared by mixing the resin of *Symphonia globulifera* with bees' wax and charcoal was employed by the Indians of British Guiana for cementing arrow heads and joining wood.

In Costa Rica (Pittier, H.: "Plantas usuales de Costa Rica" (1908) 80), the resin of *Symphonia globulifera* is mixed with wax and employed in making candles and as a caulking pitch.

According to Corrêa (Corrêa, P.: "Flora do Brasil" (1909) 15), the resin of *Symphonia globulifera* finds medicinal, veterinary and industrial uses in Brazil. Likewise it is valued in caulking and as a substitute for cobblers' wax ("A glossary of useful Amazonian flora" Coord. Inter-Amer. Aff. (mimeographed) p. 6). In Colombia, the resin, which is known as *paramán* and in the Amazonian regions as *brea*, is used for caulking the seams of boats (Pérez-Arbeláez, E.: "Plantas útiles de Colombia" (1947) 381). In the Peruvian Amazon, *Symphonia globulifera* is known as *brea-caspi* ("pitch tree") (Williams, L.: "Woods of northeastern Perú" in Field Mus. Nat. Hist. Bot. Ser. 15 (1936) 343).

The abundant, thick yellow latex of *Symphonia globulifera* is gathered in large quantities by the Makuna and Barasana Indians of the Río Piraparaná and the lower Apaporis basin for use in making torches and dancing masks, for caulking dugout canoes and for finishing the ends of poison dart quivers made of *Ischnosiphon* stems. It is also employed as a general-purpose glue in making many household articles, such as the hollow bird-bone snuffing tubes and snail-shell snuff-cases.

In the Puinave language, *Symphonia globulifera* is known as *kö*, an epithet which is sometimes applied to other species of the same genus.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná, Caño Oo-moo-ña. "Large tree. Height 60 feet. Flowers red. Latex yellow. Bark brown. Puinave = *kö*." September 3, 1952, *Richard Evans Schultes & Isidoro Cabrera 17163*.

Symphonia microphylla *R. E. Schultes sp. nov.*

Arbor parva, usque ad quadraginta quinque pedes alta, debilis sed erecta, copiose resiniflua, latice flavo. Rami late strato-patentes. Ramuli teretes, cortice cinereo, dense foliati. Petiolus crassiusculus, 3 4 mm. longus. Folia rigide subcoriacea, supra nitida et atroviridia, infra pal-

lidiora, oblanceolata, apice obtusa, basi cuneata, margine valde revoluta, plerumque 4.5 cm. longa, 1.5 cm. lata, nervis lateralibus numerosis, supra obscuris sed infra prominulis, inter se 0.5-1 mm. distantibus. Inflorescentiae abbreviatae, in ramulis lateralibus sessiles, umbelliformes, ramulis floriferis dense foliatis. Pedicelli in quoque fasciculo 6-8, straminei, plusminusve 8 mm. longi, basi bracteolis minutis, usque ad 1 mm. longis. Alabastrum subglobosum, 5–6 mm. in diametro. Sepala purpurea, subaequalia, subcrassa, late ovata, apice rotundata, margine integra, circiter 2 mm. longa, 2–2.2 mm. lata. Petala sanguinea apicem versus saepe purpurea, aestivatione non contorta, firme membranacea, valde cucullata, orbicularia, 9 mm. lata, margine integra, 8–9 mm. longa, utrinque glaberrima. Discus extrastaminalis 1.2–1.5 mm. altus, valde incrassatus. Synandrium atropurpureum, tubo lageniformi petalis subaequali, 6–7 mm. longum, laciniis maxime crassissimis, rugosis, lineari-triangularibus, stylum versus arcuatis, transversale triangularibus, 2–2.3 mm. longis, 1.8 mm. latis, parte tubiformi 3–3.2 mm. longa, antheris linearibus, ternis, flavis, 1.8 mm. longis, 0.6 mm. latis. Ovarium glabrum, oblongo-ovoideum, 2.8 mm. longum, 1.8 mm. in diametro, in stylum 4 mm. longum, apice profunde stellatim quinquedivisum, brachiis crassissimis, 2.2 mm. longis, attenuatum. Fructus adhuc ignotus.

Symphonia microphylla can be distinguished at once from the other two species of the genus through its very small, oblanceolate, obtuse leaves which are not grouped exclusively at the tips of the branchlets but are borne more or less along most of their length. The flowers are smaller than those of *Symphonia globulifera*, and the umbels are fewer-flowered and less dense than those of *S. utilissima*. In floral structure, the lobes of the synangium are much fleshier, and the stigma-bearing arms of the

style are much more carnose and longer than in either *Symphonia globulifera* or *S. utilissima*.

The resinous pitch obtained from *Symphonia microphylla* is employed by the Taiwano and Kabuyarí Indians of the Río Kananarí for the same purposes as that of *S. globulifera*.

COLOMBIA: Comisarías del Vaupés and Amazonas, Río Apaporis, Raudal de Jirijirimo. "Flowers red. Tree, 45 feet tall. Latex yellow, used as brea. Puinave = *kö;* Yukuna = *main;* Kuripako = *maí-ne.*" November 27, 1951, *Richard Evans Schultes & Isidoro Cabrera 14662* (TYPE in Herb. Gray).

Symphonia utilissima *R. E. Schultes sp. nov.*

Arbor parva, usque ad quadraginta quinque pedes alta, nunc gracilis et inter vicinas subscandens vel eis suffulta, nunc robustior et erecta, copiose resiniflua, latice flavo. Rami late strato-patentes. Ramuli teretes, cortice cinereo, apice dense foliati, internodiis 15-17 cm. longis. Petiolus leviter canaliculatus, 4–5 mm. longus. Folia subcoriacea, supra nitida et atroviridia, infra pallidiora, elliptica, longe acuminata, basi cuneata, 6–7 cm. longa, 2–2.3 cm. lata, nervis lateralibus numerosis, inter se plusminusve 1 mm. distantibus, utrinque aequaliter prominulis. Inflorescentiae abbreviatae, in ramulis lateralibus sessiles, umbelliformes, ramulis floriferis dense foliatis, internodiis brevibus, 4-5 cm. longis. Pedicelli in quoque fasciculo saepissime 8–12, flavo-virides, 8-10 mm. longi, basi bibracteolati bracteolis sanguineis, minutissimis. Alabastrum globosum, 4–6 mm. in diametro. Sepala subcoriacea, roseo-violacea, suborbicularia, plusminusve 3 mm. longa, 4 mm. lata. Petala aliquid crassa, sanguinea, aestivatione contorta, valde cucullata, orbicularia, 6–8 mm. longa et lata, margine integerrima, extus parte inclusa levi, exposita crassiore atque rugulosa. Discus extrastaminalis 0.8-1 mm. altus. Synandrium sanguineum, tubo lageniformi quam petala breviore, 4 mm.

altum, laciniis linearibus, acutis, rugulosis, 2.5 mm. longis, 1 mm. latis, parte tubiformi 2 mm. longa, antheris linearibus, ternis, flavis, 1.2 mm. longis, 0.5 mm. latis. Ovarium glabrum, subglobosum, plusminusve 1.2 mm. in diametro, in stylum 2 mm. longum, apice stellatim quinquefidum, brachiis crassis, 1 mm. longis, attenuatum. Fructus adhuc ignotus.

Symphonia utilissima differs from *S. globulifera* in its smaller, elliptic, very long-acuminate (instead of oblong or oblong-lanceolate, short-acuminate) leaves and in its much smaller flowers which are grouped more densely in umbels of from eight to twelve (instead of from three to seven).

This tree is of prime importance in the economy of the natives of the Apaporis basin. Its abundant yellow latex is gathered for use in caulking dugout canoes, and the Makuna, Tanimuka and Yukuna Indians make dancing-masks from the pitch which, when boiled, becomes black, and hardens into a firm, brittle and glossy material. The pitch from *Moronobea coccinea* is likewise used in the manufacture of the dancing masks, but *Symphonia utilissima* appears to be much more abundant in the flood-forests and more easily bled than *M. coccinea*.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, Jinogojé. "Small tree. Flowers red. Latex yellow. Highland. Spanish = *brea;* Tanimuka = *ma-ñé* and *ree-ka-vá;* Yukuna = *main;* Puinave = *kö* and *kö-lö;* Kuripako = *maí-ne;* Makuna = *go-hé-ree-ka.*" August 17, 1952, *Richard Evans Schultes & Isidoro Cabrera 16885* (TYPE in Herb. Gray).

EXPLANATION OF THE ILLUSTRATION

PLATE V. (*Upper*) Flowering branch of *Moronobea riparia* (Spruce) Planchon & Triana var. *fimbrillata* R. E. Schultes. Río Guainía, Vaupés, Colombia.

(*Lower*) Flowers of *Moronobea coccinea* Aublet from the tree which gave the collection *Schultes & Cabrera 13960*. Mitú, Río Vaupés, Vaupés, Colombia.

Photographs by RICHARD EVANS SCHULTES

Plate V

EXPLANATION OF THE ILLUSTRATION

PLATE VI. Kubeo Indian lighting torch made from the resin of *Moronobea coccinea* Aublet. Río Vaupés, Vaupés, Colombia.

Photograph by LEE SALSBERY

Plate VI

EXPLANATION OF THE ILLUSTRATION

PLATE VII. Flowering branches of *Moronobea rupicola* R. E. Schultes from the tree which furnished the type material. Cerro Isibikuri, Río Kananarí, Vaupés, Colombia.

Photograph by RICHARD EVANS SCHULTES

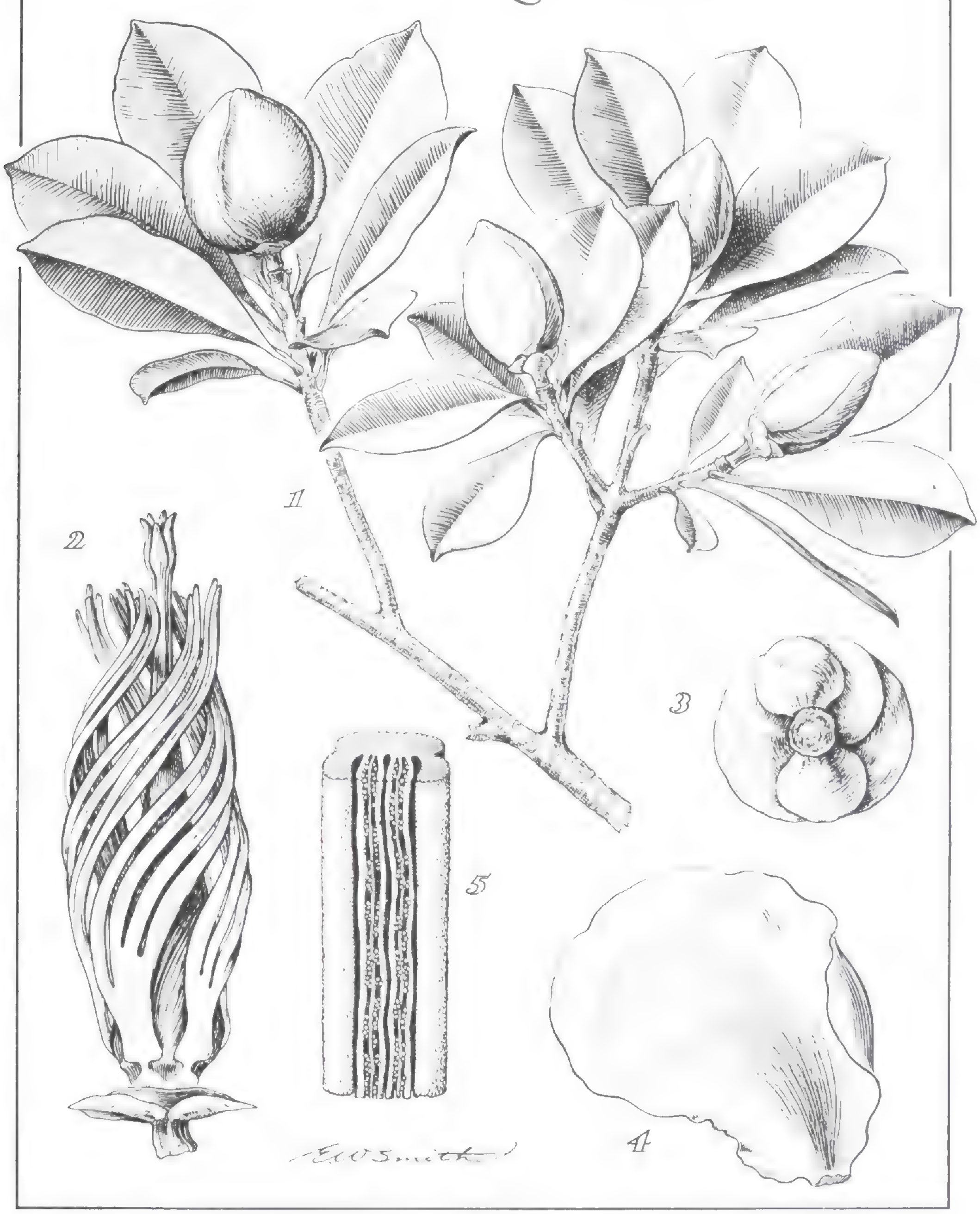
Plate VII

EXPLANATION OF THE ILLUSTRATION

PLATE VIII. MORONOBEA RUPICOLA *R. E. Schultes.* 1, flowering branch, about one half natural size. 2, flower with petals removed, about one and one half times natural size. 3, underside of calyx, about one and one half times natural size. 4, petal, natural size. 5, section of an anther, fifteen times natural size.

Drawn by ELMER W. SMITH

MORONOBEA rupicola
R.E. Schultes



EXPLANATION OF THE ILLUSTRATION

PLATE IX. PLATONIA INSIGNIS *Mart.* var. FORMOSA *R. E. Schultes.* (*Upper*) Branches showing fertilized flowers with the petals fallen and the staminal bundles drooping. From the type tree, Río Piraparaná, Vaupés, Colombia.

(*Lower*) Flowers of the type tree before fertilization.

Photographs by RICHARD EVANS SCHULTES

Plate IX

EXPLANATION OF THE ILLUSTRATION

PLATE X. SYMPHONIA MICROPHYLLA *R. E. Schultes.* 1, flowering branch, one half natural size. 1a, flower with the petals removed, about five times natural size. 1b, pistil, about five times natural size. 1c, tip of stigma arm showing stigmatic surface, about ten times natural size.

SYMPHONIA UTILISSIMA *R. E. Schultes.* 2, flowering branch, one half natural size. 2a, flower with the petals removed, about five times natural size. 2b, pistil, six times natural size.

Drawn by ELMER W. SMITH

SYMPHONIA microphylla
R.E.Schultes
1
1 b
1 c
1 a
2
2 b
2 a
SYMPHONIA utilissima R.E.Schultes

EXPLANATION OF THE ILLUSTRATION

PLATE XI. Yukuna dancing-mask made from the resin of *Symphonia utilissima* R. E. Schultes. Río Miritiparaná, Amazonas, Colombia.

Photograph by RICHARD EVANS SCHULTES

Plate XI

A NOTE ON THE GENUS JOANNESIA

BY

RICHARD EVANS SCHULTES

Joannesia princeps *Velloso* Alograf. (1790) 199.
Joannesia insolita Pittier in Bol. Soc. Venez. Cienc. Nat. 6, no. 41 (1939) 8.

In 1939, Dr. Tobias Lasser collected specimens from a tree in the yard of an abandoned house at El Peaje, along the road out of Caracas towards El Valle in Venezuela. The tree was determined as belonging to the genus *Joannesia* by Dr. Pittier who sent material to Dr. Adolpho Ducke for study.

Joannesia, had previously been known only through *J. princeps* Vell., from the coastal regions of Brazil near Rio de Janeiro, and *J. heveoides* Ducke, from the central part of the Amazon Valley. The discovery of the genus in such a distant and isolated locality as Caracas, Venezuela, was, indeed, unexpected.

Both Pittier and Ducke felt that the Venezuelan material represented a distinct species, possibly allied more closely to *Joannesia princeps*. Pittier, consequently described it as *Joannesia insolita*. In discussing the novelty, he wrote (*loc. cit.* 10): "The question still to be resolved is 'How did this, the only known individual of the species, get to its present location?' and also 'How can one explain why, in so many trips through the forests of the coastal mountains and others that surround Caracas, none

of the numerous students of our flora has met with a tree which is so unusually conspicuous?" "

A study of the type and other material from the Herbario Nacional de Venezuela, kindly sent to me on loan by Dr. Lasser, convinces me that *Joannesia insolita* must be reduced to synonymy under *J. princeps*. None of the several characters pointed out by Pittier as setting *Joannesia insolita* apart from *J. princeps* is of a major category. All are so slight that, in a group such as the *Euphorbiaceae*, they cannot be accepted as representing more than normal variations within a species. This interpretation would seem to be even more justified when one considers the significant altitudinal and habitat differences between the Caracas locality (850 m.) and the natural area of *Joannesia princeps* in the vicinity of Rio de Janeiro. Indeed, the Venezuelan material is a rather close match for some of the collections of *Joannesia princeps*.

Since the type and only tree of *Joannesia insolita* was found growing in an abandoned yard and since no other individuals have ever been found in the forests of the region, we are probably warranted in assuming that it was planted. There should be no difficulty in explaining how the tree came to be in Caracas. It is apparent that, in the 19th century, living material of *Joannesia princeps* was distributed from Rio de Janeiro to botanical gardens in widely separated areas. In the Gray Herbarium, for example, there is a specimen of *Joannesia princeps* collected in the Calcutta Botanical Garden. Consequently, I see no reason why *Joannesia princeps* could not have been introduced into Venezuela.

A NEW GENERIC CONCEPT IN THE EUPHORBIACEAE

BY

RICHARD EVANS SCHULTES

AN intensive investigation of *Hevea* (the genus of the commercial rubber tree) and its nearest relatives, which has been in progress in the Amazon forests during the past ten or twelve years, has added immeasurably to our understanding of the composition, distribution and possible evolutionary history of these groups. Results of this work have been appearing sporadically and have strengthened our belief that *Hevea* and *Micrandra* are close allies,[1] and may have had a more or less parallel evolution[2]; that both are related to the rather anomalous *Joannesia*[2]; and that the generic concept which had hitherto been known as *Cunuria* cannot be maintained as separate from *Micrandra*.[3] It is, therefore, of considerable interest that a new genus of the *Hevea-Micrandra-Joannesia* complex has now come to light.

Vaupesia *R. E. Schultes gen. nov. Euphorbiacearum.*

Arbores magnae, elatae, parco cum succo lacteo (vel

[1] This relationship was, apparently, first expressed by Bentham in 1880 (in Journ. Linn. Soc. Bot. 17 (1880) 262): "*Cunuria*, *Micrandra*, *Hevea* and *Joannesia* may be to a certain degree related to each other."

[2] Baldwin: in Journ. Hered. 38 (1947) 54–64; Baldwin: in Am. Journ. Bot. 34 (1947) 265; Baldwin and Schultes: in Bot. Mus. Leafl. Harvard Univ. 12 (1947) 325–326.

[3] Schultes: in Bot. Mus. Leafl. Harvard Univ. 15 (1952) 201–222.

saepissime apparenter absenti), foliis alternis, petiolatis, stipulis infraaxillaribus folia juniora involventibus caducis. Folia integra, penninervia, coriacea, pagina supra basim biglandulosa, costis secundariis angulo amplo decurrentibus, arcuatis, tertiis subparallelis. Inflorescentiae bisexuales, paniculiformes, valde floribundae. Pedunculi axillares et terminales, foliis subaequales vel breviores, rigidi. Flores monoeci, petaliferi. Flores staminati; sepala quinque, valde imbricata, quincuncialia; petala calycis lobis alternantia; disci glandulae quinque, vulgo liberae, petalis alternantes. Antherae in columna centrali verticillatim insertae, inferiores disci lobis alternantes, birimosae. Flores pistillati: sepala quinque, eis maris similia; discus hypogynus annularis vel subannularis, glanduloso-lobatus; ovarium liberum, triloculare, loculis uniovulatis; stylus sessilis, tripartitus divisionibus bifidis, erectis vel leviter patentibus. Fructus capsularis; capsula magna, subglobosa, in coccos bivalves partiens, epicarpio carnoso et endocarpio crasso lignoso. Semina magna, ovoidea, testa crustacea, immaculata, ecaruncu-
lata; albumen carnosum; cotyledones planae, latae.

Generis species typica: *Vaupesia cataractarum.*

Generis nomen regionem in qua haec arbor reperta est perstringit.

Vaupesia cataractarum *R. E. Schultes sp. nov.*

Arbor usque ad sexaginta ad octoginta pedes alta (saepe minor) et usque ad decem pollices in diametro. Truncus erectus, columnaris, sine radicibus tabularibus, tenui cum cortice flavo-cinereo vel albido-cinereo, exfoliato; succo aquoso valde sparsissime lacteo-albo vel frequenter sanguineo, siccitate aliquid cretaceo (vel saepe apparenter absenti). Rami saepe succo amplo aquoso sanguineo instructi, teretes, tenui cum cortice albido-luteo obtecti. Folia valde crasso-coriacea, supra atrovi-

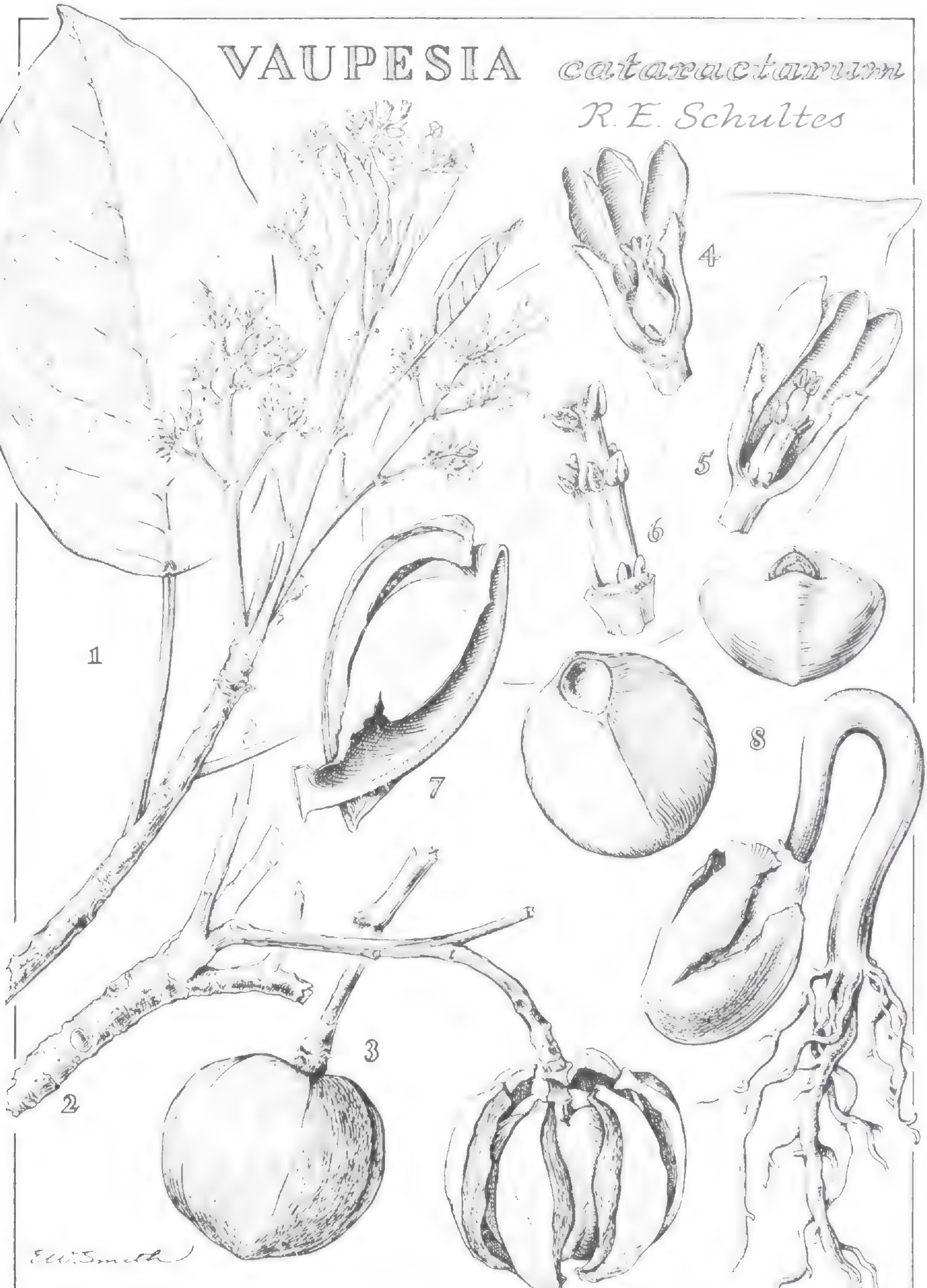
ridia laetaque, infra pallidiora hebetiaque, perfecte nervum centralem versus angulo 90° plicata, ovata vel rarenter elliptico-ovata, omnino glaberrima, in specimine typico 16–19 cm. longa, plusminusve 10 cm. lata, apice breviter acuminata vel saepe obscurissime subacuta, basi vulgo perfecte rotundata, valde et conspicue marginata, venis supra non conspicuis sed infra elevatis, secundariis decem ad duodecim leviter arcuato-adscendentibus, tertiis reticulatis subparallelis, glandulis magnis, oblongis, usque ad 4 mm. longis; foliis juvenilibus papyraceis, lineari-lanceolatis, apice acuminatis, basi cuneatis, marginatis, 20–27 cm. longis, 5.5–8 cm. latis. Petiolus tenuis, siccitate striato-fibrosus, 6–9 cm. longus (saepe longior), usque ad 3 mm. in diametro. Inflorescentiae rigidae, plerumque 9–13 cm. longae, rhachide glabra, cortice rufo-purpureo. Bracteae flores subtendentes stramineae, acuto-subulatae vel late triangulares, plerumque 4–5.5 mm. longae, basi 2.5–3.5 mm. latae, glabrae sed apicem versus saepe minute rufo-barbellatae. Flores lutei, in sole valde aromatico-pungentes, terminales majores saepissime pistillati sed saepe staminati. Flores pistillati: apice usque ad 5–6 mm. in diametro, calyces 10 mm. longi, extus minutissime scobiculato-pulverulenti, intus glaberrimi, $\frac{1}{3}$ partis divisi, laciniis margine conspicue ciliato-fimbriatis, tres exteriores majores, rhombico-spathulati cum apicibus lateraliter contiguis, subcucullati, apice rotundati sed in anthesi nunc vi fissi, 4 mm. longi, 3.5 mm. lati, duo interiores ovati, 3 mm. longi, 2–2.5 mm. lati; petala membranacea, obovata, 9 mm. longa, 4.5 mm. lata, apice leviter subcucullata, margine integra; discus hypogynus ovario adnatus, quinqueloba-tus, lobis variabilibus sed saepissime late rotundatis vel triangulari-subulatis, 1 mm. longis, 0.5–1 mm. latis, basi in vivo apparenter sanguineus: ovarium longe pyramidali-conicum, subtrigonum, glabrum, 4.5 cm. longum, plus-

EXPLANATION OF THE ILLUSTRATION

PLATE XII. VAUPESIA CATARACTARUM *R. E. Schultes*. 1, flowering branch, about one half natural size. 2, fruiting branchlet, with capsule ready for dehiscence, about one half natural size. 3, capsule before the drying out of the epicarp, about one half natural size. 4, pistillate flower with part of calyx and two petals removed, about two and one half times natural size. 5, staminate flower with part of the calyx and two petals removed, about two and one half times natural size. 6, staminal column with anthers, about four times natural size. 7, one valve of the capsule with epicarp adhering, about natural size. 8, seeds, with one germinating, about natural size.

Drawn by ELMER W. SMITH

PLATE XII

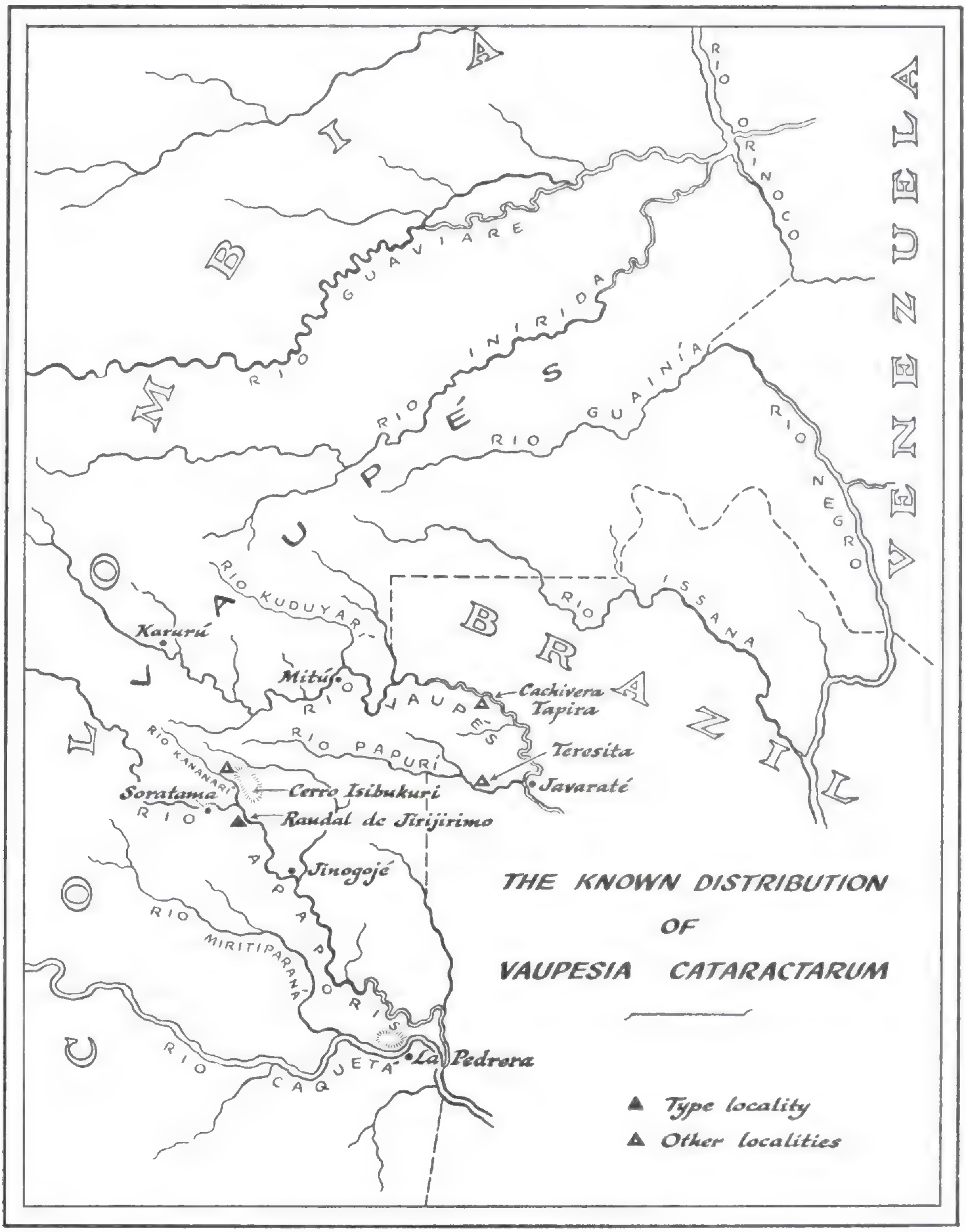


EXPLANATION OF THE ILLUSTRATION

PLATE XIII. Map showing the known distribution of *Vaupesia cataractarum*.

Drawn by ELMER W. SMITH

Plate XIII


VENEZUELA
BRAZIL
COLOMBIA
RIO GUAVIARE
RIO INIRIDA
RIO GUAINÍA
RIO NEGRO
RIO ISANA
RIO KUDUYARI
RIO PAPURÍ
RIO KANANARÍ
RIO MIRITIPARANÁ
RIO CAQUETÁ
RIO APAPORIS
Karurú
Mitú
Cachivera Tapira
Teresita
Javaraté
Cerro Isibukuri
Raudal de Jirijirimo
Soratama
Jinogojé
La Pedrera
THE KNOWN DISTRIBUTION
OF
VAUPESIA CATARACTARUM
Type locality
Other localities

minusve 2 mm. in diametro; stylus tripartitus cum divisionibus bifidis, erectis, 1.5 mm. longis. Flores staminati: terminales pistillatis similes, laterales structura aequales sed partibus omnibus minores; florum staminatorum terminalium disci glandulae ad columnae staminalis basim insertae, parvae, erectae, oviformi-ellipsoideae, 0.5 mm. longae vel breviores; columna crassissima, usque ad 10 mm. longa, basi plusminusve 1.5 mm. in diametro, supra verticillum inferiorem 1 mm. in diametro sed omnino cylindrica, non attenuata; antherae octo, quinque in verticillo inferiore, ad columnae basim 3–3.5 mm., et tres in verticillo ad columnae apicem, aequales, 0.8–1 mm. longae. Fructus globosus vel subglobosus, vivo plusminusve 5 cm. longus, 4.8–5 cm. in diametro, siccitate vix minor, apice rotundato-obtusus, basi aliquid depressus, epicarpio nitido, atroviridi, saepe maturitate paulo purpurascenti, magnopere crassissimo (vivo saepe 6 mm. crasso), endocarpio lignoso, comparate tenui (usque ad 2.5–3 mm. crasso), valvis regularibus, plerumque 4.5 cm. longis, 2 cm. latis; pedunculo vulgo longissimo, robusto, usque ad 8–12 cm. longo, 4 mm. in diametro. Semina cum testa rufo-brunnea et conspicue hebeti, in circuitu longitudinali rotundato-ovalia, plusminusve 30 mm. longa, 26 mm. lata, compressa, 18 mm. crassa, in circuitu transversali inaequaliter rhomboidea, superficiebus duabus ventralibus conspicuis, carina dorsali prominenti, hyli cicatrice conspicua, subrotundata vel subtriangulari, 6–7 mm. longa lataque, prope apicem cicatricum versus rostello instructa.

COLOMBIA: Comisarías del Amazonas and Vaupés, Río Apaporis, Cachivera de Jirijirimo and vicinity. Altitude about 800 feet. "Tree 50–55 feet tall. Diameter 8–10 inches. Flowers yellowish. Latex chalky white. Bark flaky, grey-white. Leaf like *Cunuria Spruceana* with which it grows. Common." September 16, 1951, *Richard Evans Schultes & Isidoro Cabrera 14006* (TYPE in Herb. Gray).—Same locality. "Tree 60 feet tall. Diameter 1 foot. Bark greenish grey. No

latex." June 12, 1951, *Schultes & Cabrera 12431*.—Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri, at base of mountain. Quartzite. Altitude about 800 feet. "Large tree. Bark whitish grey, rough. Latex very watery, reddish." August 4, 1951, *Schultes & Cabrera 13339*.—Same locality. "Tree 100 feet tall. Latex red only in the branches." January 23–25, 1952, *Schultes & Cabrera 15059*.—Comisaría del Vaupés, Río Vaupés, between Mitú and Javareté, Raudal de Tapira. In rocky high land covered with humus along rapids. "Fluted tree. Diameter 26 inches. Bark yellowish, tawny, papery, peeling easily. Inner bark reddish. No latex. Wood hard, centre reddish brown. Height 80 feet. Crown large. Leaves folded at right angles along midrib, slightly paler beneath, somewhat crassulent or fleshy. Bark on extreme branches whitish yellow. Seeds brown, dull. Capsules with thin woody wall, thick epiderm green but reddening before breaking. Desano = *ma-há-wa-soo*. Together with *Micrandra Spruceana* and *Hevea pauciflora* var. *coriacea*." May 14–24, 1953, *Schultes & Cabrera 19344*.—Same locality and date. *Schultes & Cabrera 19345, 19346, 19347, 19353*.—Comisaría del Vaupés, Río Papurí, Teresita. Caatinga forest. "Large columnar tree; diameter 18 inches; height 60 feet. Crown large. No latex. Bark papery, yellowish grey." May 27, 1953, *Schultes & Cabrera 19440*.—Same locality and date. "Large columnar tree, 60–70 feet tall. Crown large. No latex. Seeds eaten after boiling." *Schultes & Cabrera 19444*.—Same locality and date. *Schultes & Cabrera 19451*.

All of the collections cited above are from Colombian territory, but, in several cases, they were made along rivers (the Vaupés and the Papurí) forming part of the boundary between Colombia and Brazil. I have seen hundreds of trees of *Vaupesia cataractarum* on the Brazilian bank, so we must report this species as occurring in both countries. It might, also, later be found in that part of Venezuela adjoining the Río Negro and the Río Guainía, even though relatively intensive studies of *Hevea* and *Micrandra* in that area have not, as yet, disclosed its presence there.

When I first met with *Vaupesia* in the field, I thought that I had found a new species of *Micrandra* (including *Cunuria*), notwithstanding the presence of petals. The general habit and appearance of the tree is, indeed, so

EXPLANATION OF THE ILLUSTRATION

PLATE XIV. Trunk of the tree from which the type of *Vaupesia cataractarum* was taken.

Photograph by RICHARD EVANS SCHULTES

Plate XIV

strikingly similar to several of the species of *Mierandra* with which it grows that even the Indians of the region use the same name for *Vaupesia cataractarum* and for *Mierandra Rossiana* R. E. Schultes and *M. Sprucеana* (Baill.) R. E. Schultes. Close examination, however, discloses the extraordinary distinctness of the new concept.

All of the characters of *Vaupesia* place it in the *Mierandra-Hevea-Joannesia* complex. The leaves are very definitely mierandroid, departing sharply from the three-foliolate leaves of *Hevea* and the usually five-foliolate ones of *Joannesia*. The capsule, valves and seeds of *Vaupesia* likewise resemble those of *Mierandra* very strongly. Indeed, if I had collected nothing but fruiting material, I would, without hesitation, have described it as a new species of *Mierandra*.

The type of inflorescence and the petaloid flowers resemble those of *Joannesia* to a remarkable degree, even though the calyx is quite mierandroid and entirely unlike the undivided calyx of *Joannesia*. The presence of a watery red resinous liquid in the bark of many trees of *Vaupesia* recalls a similar condition in *Joannesia heveoides* Ducke.

The whorled disposition of the anthers on a fleshy staminal column definitely indicates a relationship with *Hevea*. Nevertheless, the morphology of the column might be interpreted as rather intermediate between *Joannesia* and *Hevea*. We are able to point out a complete series, tending towards fusion of the filaments, from *Mierandra* (with free filaments) and *Joannesia* (with the filaments basally connate) through *Vaupesia* (with the filaments totally fused into a column which, however, shows by fluting the position of the individual filaments) to *Hevea* (with a perfectly terete column).

A comparison of the disks of both the pistillate and staminate flowers suggests, perhaps, a closer alliance with

Joannesia than with either *Hevea* or *Micrandra*. The structure of the stigmas, on the other hand, is definitely micrandroid.

Dr. Grady L. Webster, Research Fellow in Biology at Harvard University, has made a study of the pollen grains of *Vaupesia* and of related genera. His observations follow:

"The pollen-grains of *Vaupesia cataractarum* are characterized by a 'Croton-pattern' of ornamentation, as defined by Erdtman[4]. When expanded in lactic acid, they are spherical, about 72–77μ in diameter, and apparently non-aperturate. The ornamentation is due to a dense exinous layer of knob-like processes arranged, as illustrated by Erdtman for *Manihot* and *Jatropha* (op. cit., 170), in rings of five or six around a dim, circular area. The knobs in *Vaupesia* are about 4μ long and roundish or 3–5-angled in cross-section.

"Of the genera in the *Hevea*-complex, *Joannesia* shows the greatest similarity to *Vaupesia* in pollen morphology. The grains of *Joannesia princeps* are about the same size and have a very similar pattern of exinous knobs. In fact, one could not, on the basis of pollen morphology alone, distinguish the two genera. *Micrandra* and *Hevea*, on the other hand, have colporate grains and, palynologically, at least, stand further away."

Are we not justified in believing that *Vaupesia* represents, perhaps, a concept linking more closely the *Micrandra-Joannesia-Hevea* complex! And, likewise, may we not interpret *Vaupesia* as possibly a vestige of an ancient prototype of what we now see differentiated into *Micrandra*, *Joannesia* and *Hevea*?

Speciation in both *Hevea* and *Micrandra* has occurred to a much greater extent in the basin of the upper Río

[4] Erdtman, G.: Pollen Morphology and Plant Taxonomy (1952) 173.

Negro and Vaupés than in any other area. Here are represented not only the greatest number of species of these two widespread groups, but endemism indicates that both *Hevea* and *Mierandra* may represent very ancient elements of the flora of this phytogeographically critical region.

The genus *Joannesia* is not represented, so far as we know, in this area. Its distribution is rather local: one species occurs in the coastal region of Brazil near Rio de Janeiro; a second is known from the Rio Tapajóz in the eastern Amazon.

The flora of the caatingas and caatinga-forests in the upper Río Negro-Vaupés basin shows very close affinities with that of the ancient Venezuela-Guiana land-mass. In fact, these caatingas (locally called "savanetas" in Colombia) are found in eastern Colombia either on the isolated quarzitic mountains of Cretaceous age (or on extensive sandy stretches associated with such mountains) or on granitic hills of the pre-Cambrian "Brazilian shield." The very numerous rapids in the rivers of the Colombian Comisaría del Vaupés are likewise associated with these quartzitic rocky outcrops or, along the Brazilian boundary, with granitic outcrops. *Vaupesia cataractarum* has been collected from caatinga-forests along both the quartzitic and the granitic cataracts: the type locality (the Falls of Jirijirimo on the Río Apaporis) and the base of Cerro Isibukuri, the western and southernmost stations known for the genus are quartzitic; the Falls of Tapira on the Río Vaupés and at Teresita on the Río Papurí are granitic. Both of these geological associations support peculiar and, presumably, ancient floras and seem to be repositories for endemic and apparently primitive species. We might enumerate many, but it will perhaps suffice to name several allies of the new genus: *Hevea rigidifolia* (Spruce ex Benth.) Muell.-Arg., *Mierandra*

Lopezii R. E. Schultes and *M. Spruceі* (Muell.-Arg.) R. E. Schultes, known only from the granitic caatinga-forests; *H. nitida* Mart. ex Muell.-Arg., *H. pauciflora* (Spruce ex Benth.) Muell.-Arg. var. *coriacea* Ducke and *Micrandra Rossiana* from both the granitic and quartzitic areas; and *H. nitida* var. *toxicodendroides* (Schult. & Vinson) R. E. Schultes, exclusively from the quartzitic mountains.

Vaupesia cataractarum occurs in caatinga-forests in close association with *Micrandra Spruceana* and *Hevea nitida*. Other tree-associates are *Monopteryx Uaucu* Spruce ex Benth. and *Couma catingae* Ducke. In the locality on the Río Papurí, it grows in stands which comprise almost exclusively *Vaupesia cataractarum* and *Micrandra Sprucei*.

The habitat of *Vaupesia cataractarum*, as the specific epithet implies, usually consists of hilly or sloping areas alongside or very near rapids. The ground is strewn with huge rocks, between which humus and sand has accumulated, creating a highly acid condition. In addition to the ample rainfall (more than 3 meters a year) which drenches the forests of this region, the sites chosen by *Vaupesia cataractarum* are almost perennially soggy as a result of the numerous rills and freshets that flow down from the higher hinterlands to empty into the river near the rapids.

The Desano Indians, speaking a Tukanoan dialect, refer to this tree as *ma-há-wa-soo* (''macaw-cunurí''), the same name which they apply to *Micrandra Rossiana* and *M. siphonioides* Benth. They know the superficially similar *cunurí* (*Micrandra Sprucei*) as *wa-soó*.

From late March through May, the large seeds of *Vaupesia cataractarum* fall in astonishingly large amounts. They are harvested from the ground by the Indians for food. Like the seeds of *Hevea* and *Micrandra*, they are

extremely poisonous, until boiling breaks down the cyanic substances. They are also extremely rich in oil.

There is one important aspect of *Vaupesia cataractarum* which is still a puzzle. Sometimes a white, watery latex is present in the bark of the basal part of the trunk, but usually no trace of such a latex can be found. When present, it is a curiously resinous liquid drying to form a rather chalky white substance which easily crumbles in the hand. One tree (*Schultes & Cabrera 13339*) had a watery latex of a reddish color in the trunk, whereas nearly all of the more than eighty trees which I examined closely in the several localities possessed this reddish latex abundantly in the terminal branches, even when no evidence of it could be found elsewhere in the plant. Information from the Indians indicates that these anomalous conditions are not seasonal, and my own studies convince me that there is no relationship between the presence or absence of latex and its color and ecological factors. At first, I suspected that perhaps distinct varieties or forms might explain the problem, but there is no morphological evidence that we have at hand any taxonomic variants. In thus reluctantly leaving this interesting puzzle unsolved for the present, I must emphasize again the presence in *Joannesia hevcoides* of a very similar thin, watery, red latex. *Joannesia*, of course, does not have the white latex common to all of its presumed allies, nor do these allies--*Hevea* and *Micrandra* -- possess the red latex of *Joannesia* and *Vaupesia*.

The drawing of *Vaupesia cataractarum* and the distribution map published herewith were made possible through a grant from the United States Department of Agriculture with which I was associated when this new genus was discovered. I wish to express my appreciation to Dr. Julian A. Steyermark for his interest and advice in my treatment of this new concept.

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FURTHER NOTES ON AMERICAN ORCHIDS

BY

CHARLES SCHWEINFURTH

THE following notes were assembled during the work of identifying various tropical American collections and particularly in the course of preparing an intensive orchid flora of Peru.

The sequence of genera follows the System of Classification proposed by Dr. Schlechter in Notizblatt des Botanischen Gartens und Museums Berlin-Dahlem, Band 9, Nr. 88 (1926) 567–591.

Habenaria repens *Nuttall* Gen. N. Am. Pl. 2 (1818) 190.—Kränzlin Orch. Gen. et Sp. 1 (?1901) 315.—Cogniaux in Martius Fl. Bras. 3, pt. 4 (1893) 91.

Platanthera foliosa Brongniart in Duperr. Bot. Voy. Coquille, Phan. 195 (1829) t. 38B.

Habenaria maxillaris Lindley in Hook. Journ. Bot. 1 (1834) 5; Gen. & Sp. Orch. (1835) 310.

Careful study of the descriptions of *Habenaria maxillaris* Lindl. (and of the plate of *Platanthera foliosa* Brongn. which is considered to be synonymous) has convinced me that this concept is inseparable from *Habenaria repens* Nutt., a species of very wide distribution and a plant of considerable variability. In fact the only significant difference between the two species appears to lie

in the lateral lobes of the lip which in *H. maxillaris* are described as a little shorter than the mid-lobe, whereas in *H. repens* they are more or less longer than the mid-lobe. In such a variable group as Habenaria, however, the relative length of the lobes of the lip has been found to be inconstant.

This species extends from North Carolina (U.S.A.) through the West Indies, Central America and South America to Paraguay and Argentina.

Stelis gracilifolia *C. Schweinfurth sp. nov.*

Herba pro genere mediocris, caespitosa, epiphytica. Caules abbreviati, vaginis arcte tubulatis evanidis omnino velati. Folium adscendens, lineare vel oblanceolato-lineare, infra in petiolum plusminusve distinctum sensim angustatum, in siccitate valde coriaceum. Inflorescentia unica, quam folium conspicue brevior, erecta, supra dense multiflora. Flores perparvi, carnosi, brunneo-purpurei. Sepala rotundato-ovata, simillima, late obtusa, inferne connata, trinervia, intus minute papillosa. Petala multo minora, cuneato-flabellata, apice lato incrassata. Labellum ovatum vel oblongo-ovatum, late obtusum, multo incrassatum. Columna abbreviata.

Plant medium-sized for the genus, caespitose. Roots numerous, fibrous, glabrous, slender. Stems abbreviated, up to 3 cm. long, entirely concealed by two or three close tubular evanescent sheaths. Leaf ascending, linear or (inclusive of the petiole) oblanceolate-linear, obtuse and minutely apiculate at the apex, gradually narrowed to a more or less distinct channelled petiole, very thick and fleshy when fresh (or when boiled), 8–17.2 cm. long, 5–6 mm. wide in the dried plant. Inflorescence solitary, erect, up to 12.7 cm. long; raceme densely many-flowered, up to 8.3 cm. long. Floral bracts abbreviated, broadly infundibuliform, shorter than the pedicellate ovary. Flow-

ers very small, fleshy, distichous, maroon. Sepals very similar, round-ovate, broadly obtuse, connate below the middle, 3-nerved, glabrous without, densely minute-papillose within, up to about 3 mm. long (including the basal connate portion) and 2.8 mm. wide. Petals transverse, cuneate-flabellate, fleshy-thickened above with a subtruncate or broadly rounded apex, 1-nerved, about 0.75 mm. long and 1.2 mm. wide. Lip ovate or oblong-ovate, broadly obtuse, fleshy-thickened with erect sides, semirhombic when viewed from the side, about 0.9 mm. long and somewhat narrower. Column abbreviated.

This species is allied to *Stelis latipetala* Ames, but differs in having shorter and more slender stems and leaves, and about twice larger flowers.

Costa Rica: Prov. of Puntarenas, between Golfo Dulce and Río Térraba, at 30 meters altitude, "in tree top," flowers maroon, December 1947, *Alexander F. Skutch 5336* (Type in U.S. Nat. Herb. 1945424).

Pleurothallis aurea *Lindley* in Ann. & Mag. Nat. Hist. 12 (1843) 397; Fol. Orch. Pleurothallis, p. 33, no. 201 (1859).

Pleurothallis asperilinguis Reichenbach filius & Warscewicz in Bonpl. 2 (1854) 114.—Lindley Fol. Orch. Pleurothallis, p. 34, no. 202 (1859).

Humboldtia asperilinguis O. Kuntze Rev. Gen. Pl. 2 (1891) 667.

Humboldtia aurea O. Kuntze Rev. Gen. Pl. 2 (1891) 667.

In the original description of *Pleurothallis asperilinguis*, this concept was differentiated from *P. aurea* by having 3-nerved, instead of 1-nerved, petals and by having its flowers half as large as those of the latter species.

However, an excellent photograph of the type of *P. aurea* from the Delessert Herbarium shows some petals which appear to be more or less distinctly 3-nerved, as

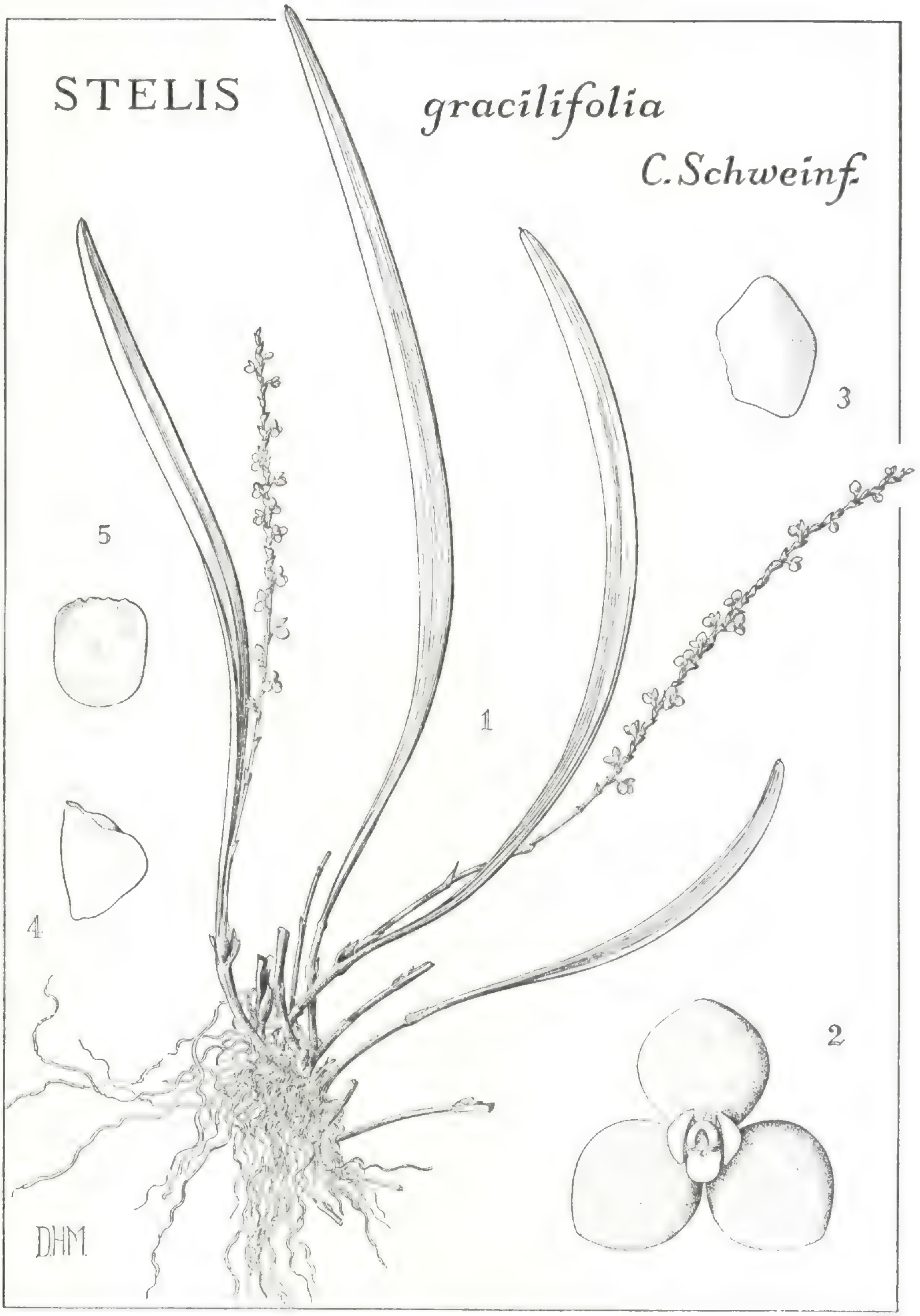
EXPLANATION OF THE ILLUSTRATION

PLATE XV. STELIS GRACILIFOLIA *C. Schweinf.* 1, plant, three fourths natural size. 2, flower from front, expanded, six times natural size. 3, petal, fifteen times natural size. 4, lip from side, fifteen times natural size. 5, lip from above, fifteen times natural size.

Drawn by DOROTHY H. MARSH

PLATE XV

STELIS *gracilifolia* C. Schweinf.



in *P. asperilinguis*. Although the drawing of *P. asperilinguis* from the Reichenbach Herbarium (in the Ames Herbarium) does not show clearly the dimensions of the flowers, they appear to be but little smaller than those of *P. aurea*. The description of *P. aurea* mentions the glandular-scabrous or pubescent inner surface of the sepals, a character which appears in all of the collections that have the 3-nerved petals and the smaller flowers.

Another character cited in the description of *P. asperilinguis* (and the one that undoubtedly furnished the specific name) is the roughness caused by the acute papillae near the apex of the lip. This character is to be observed to a more or less degree in all of these collections having 3-nerved petals.

The type description of *P. asperilinguis* mentions that the lip is 5-nerved, a characterization which seems highly dubious.

Pleurothallis aurea occurs in Venezuela (where the type was collected), Ecuador and Peru (type of *P. asperilinguis*).

Pleurothallis secunda *Poepp. & Endl.* var. **longiracema** (*C. Schweinf.*) *C. Schweinfurth comb. nov.*

Pleurothallis Lindenii Lindl. var. *longiracema* C. Schweinfurth in Bot. Mus. Leafl. Harvard Univ. 16 (1953) 53.

It has recently been called to my attention by Mr. Leslie A. Garay of Toronto, Canada, that the concept *Pleurothallis Lindenii* Lindl., which was described in Ann. & Mag. Nat. Hist. 12 (1843) 397, was considered by Reichenbach f. (in Bonpl. 3 (1855) 72) to be referable to the earlier *P. secunda* Poepp. & Endl., which appeared in Nov. Gen. ac Sp. 1 (1836) 49, t. 85.

Accordingly, it becomes necessary to make the new combination cited above which was originally attributed to *Pleurothallis Lindenii*.

Amblostoma gracile *Garay* var. **robustum** *C. Schweinfurth var. nov.*

Herba caulibus crassioribus et foliis latioribus et florum colore diversa et labelli lobis subaequalibus a specie differt.

Plant relatively robust, with a stout creeping rhizome, about 33 cm. high. Stems approximate, spreading-ascending, fusiform, several-jointed, entirely concealed nearly to the apex by several close, scarious, evanescent, tubular sheaths, 15–17.5 cm. long. Leaves four, variable in shape and size, clustered near the apex of the stem, oblong-lanceolate to linear, narrowed above to an abrupt, subacute and apiculate or obtuse apex, slightly narrowed below to a sessile clasping base, up to 12 cm. long and 1.5 cm. wide. Inflorescence solitary, strict, racemose, up to about 16 cm. long (incomplete in our specimen), subdensely many-flowered nearly to the base, slightly pubescent. Floral bracts spreading, triangular-lanceolate, acuminate. Pedicellate ovaries about twice as long as the bracts, densely pubescent. Flowers very small, whitish green with pale brown sepals and incurved segments. Sepals very fleshy. Dorsal sepal oblong-elliptic, obtuse and apiculate, strongly concave, about 4.2 mm. long and 2.1 mm. wide. Lateral sepals similar, obliquely elliptic-oblong and slightly broader above the middle, acute, deeply concave, about 4.6 mm. long and 2.4 mm. wide. Petals oblanceolate-linear, obtuse, about 4 mm. long and 0.9 mm. wide, slightly oblique. Lip entirely adnate to the column, small, tripartite, about 1.3 mm. long; lateral lobes obliquely obovate-subquadrate, partially concealed by an ovate-oblong, incurved lamina which is free along the anterior margin; mid-lobe slightly longer and narrower, ovate-oblong, subacute, with three narrow fleshy calli of which the central one is much the longest. Column relatively large, obliquely obovoid-infundibuli-

form when viewed from the side, with lacerate apical margins.

PERU: JUNÍN; Prov. of Tarma, Agua Dulce, at 1900 meters altitude, in large clumps on tree in low highland forest, March 16, 1948, *F. Woytkowski 35476* (TYPE in Herb. Univ. Calif.).

Epidendrum eximium *L. O. Wms.* var. **Amesianum** (*Correll*) *C. Schweinfurth comb. nov.*

Epidendrum Amesianum Correll in Amer. Orch. Soc. Bull. 16 (1947) 106, t. (p. 107).

The characters which distinguish *Epidendrum eximium* from the outwardly similar *E. Amesianum* are enumerated in the following tabular comparison.

E. eximium	*E. Amesianum*
Flowers whitish yellow with purple on the lip	Flowers greenish
Petals 7–8 mm. wide	Petals 12–14 mm. wide
Lip without prominent keels, broadly rounded at the apex	Lip with a prominent median keel, retuse at the apex
Column prominently lobulate on the summit	Column merely crenulate on the summit

Because these discrepancies seem to be of minor importance, I feel justified in regarding *E. Amesianum* merely as a variety of *E. eximium*.

Scaphyglottis decipiens *C. Schweinfurth sp. nov.*

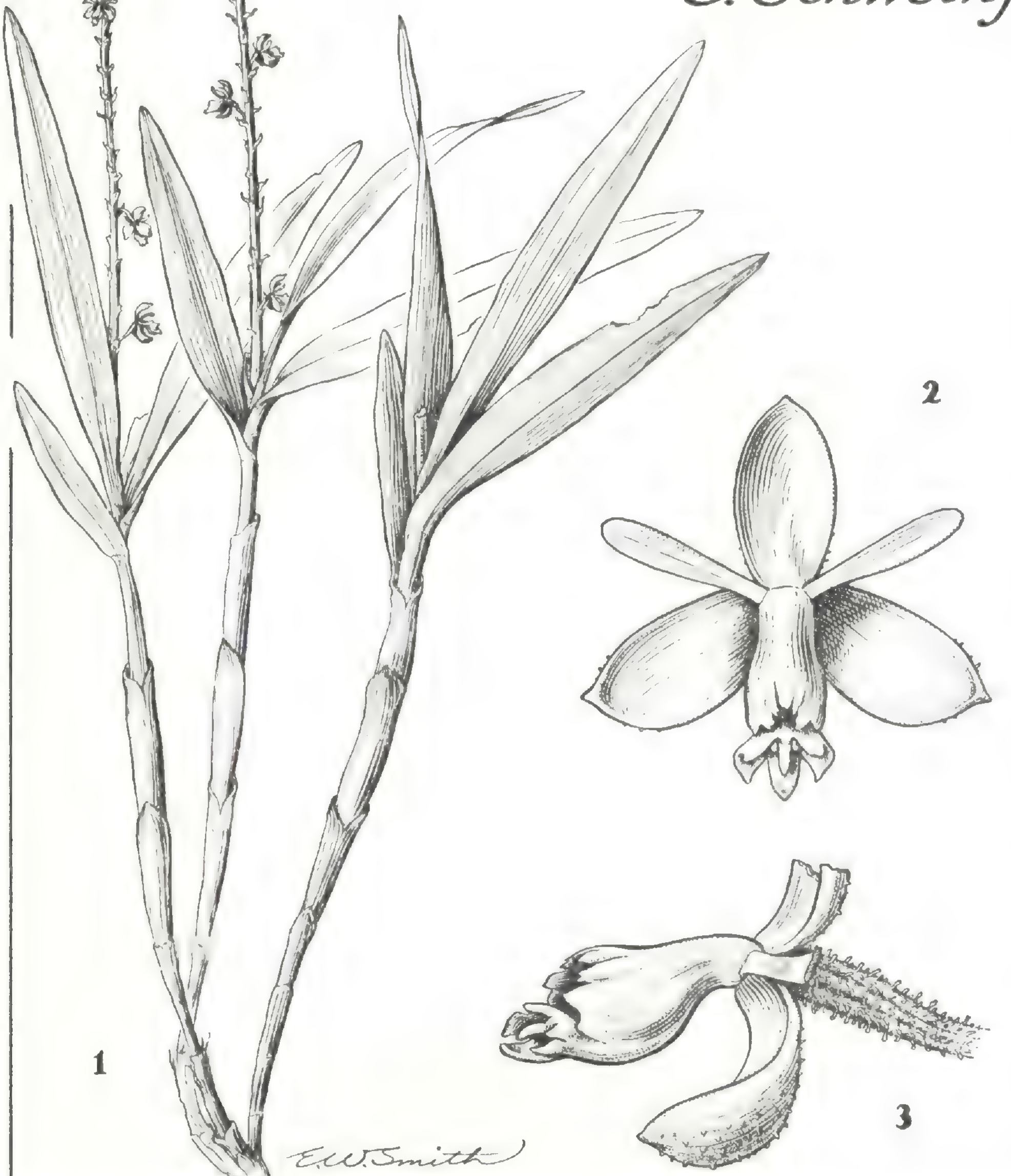
Herba gracilis, caespitosa, epiphytica. Caules tenues, maxima pro parte superpositi, in nodis saepe furcati et radiciferi, vaginis imbricatis foliiferis inferne celati, vetustiores nudi. Folia in nodis geminata, anguste linearia, sessilia, apice minutissime bilobato et apiculato, nervosa, graminea. Inflorescentiae axillares, perbreves, saepissime bifloraе. Sepalum dorsale oblongum, longitudinaliter concavum, apice acuto cucullatum. Sepala lateralia oblonga, valde obliqua, acuta, cum columnae pede mentum saccatum formantia. Petala falcato-linearia. Labellum in

EXPLANATION OF THE ILLUSTRATION

PLATE XVI. AMBLOSTOMA GRACILE *Garay* VAR. ROBUSTUM *C. Schweinf.* 1, plant, one half natural size. 2, flower expanded, five times natural size. 3, column and lip from side, six times natural size.

Drawn by ELMER W. SMITH

AMBLOSTOMA
gracile Garay
var. robustum
C. Schweinf.



EXPLANATION OF THE ILLUSTRATION

PLATE XVII. SCAPHYGLOTTIS DECIPIENS *C. Schweinf.* 1, plant, one half natural size. 2, flower from side, natural position, three times natural size. 3, dorsal sepal, four times natural size. 4, lip expanded, four times natural size. 5, column, three quarters view, petal and lateral sepal expanded, four times natural size.

Drawn by DOROTHY H. MARSH

SCAPHYGLOTTIS *decipiens*
C. Schweinf.

positu naturali erectum, columnae parallelum, tubulari-concavum et apice recurvum, trilobatum; lobi laterales truncato-rotundati, erecto-incurvi; lobus medius ovatus. Columna prope apicem utrinque dentata.

Plant slender, caespitose, epiphytic, up to 29.5 cm. high. Roots fibrous, numerous, glabrous, slender. Stems slender, often superposed, sometimes forking and producing roots at the nodes, up to 10 cm. long (the upper members much shorter), when young concealed below by several close distichous sheaths bearing leaf-blades which increase in size upward, becoming naked in age. Leaves mostly in pairs, subopposite at the nodes, narrowly linear, sessile, up to 19.5 cm. long and 4 mm. wide, minutely bilobed and apiculate at the apex, slightly narrowed and more or less conduplicate above in the dried specimen, nervose with five nerves more prominent, gramineous. Inflorescences one or two in the axils of the upper leaves, abbreviated, about 2-flowered. Flowers whitish. Dorsal sepal oblong, acute, longitudinally concave, cucullate at the apex, distinctly 3-nerved, about 6 mm. long and 2 mm. wide. Lateral sepals oblong, very oblique, acute, longitudinally concave, dorsally keeled at the apex, concave-saccate at the base and forming a short spur-like mentum with the short column-foot, about 5.5 mm. long and 2 mm. wide. Petals obliquely falcate-linear, abruptly acute, 3-nerved, about 6 mm. long and 1.2 mm. wide slightly above the middle. Lip erect and parallel to the column in natural position, longitudinally concave, recurved and sharply 3-lobed near the apex, about 6.2 mm. long when expanded; lateral lobes erect in natural position, dilated from a gradually cuneate base, obliquely rounded-subtruncate at the free apex; mid-lobe triangular-ovate, subacute, about 1.3 mm. long; disc 5-nerved, with a pair of obscure fleshy calli between the lateral lobes. Column straight, deeply longitudinally concave in

front, with a short falcate-triangular tooth on either side of the rostellum, about 5 mm. long at the back, extended into a short excavated foot. Anther semiglobose, with a bidentate membranaceous tip. Pollinia four, strongly complanate, obliquely semiovate.

This species is very similar to *Scaphyglottis longicaulis* S. Wats. (*S. unguiculata* Schltr.), but has a dissimilar lip. It also appears to be closely allied to two South American species. It differs from the Colombian *S. stricta* Schltr. in having shorter stems, narrower leaves and a prominently armed column. It varies from the Peruvian *S. Huebneri* Schltr. in having consistently larger flowers with narrower segments and a differently proportioned lip.

COSTA RICA: Prov. of Puntarenas, between Golfo Dulce and Río Térraba, at 30 meters altitude, on tree trunk, December 1947, *A.F. Skutch 5314* (TYPE in U.S. Nat. Herb. 1945422; ISOTYPE in Herb. Ames No. 65461).

Scaphyglottis propinqua *C. Schweinfurth sp. nov.*

Herba magna, vagans. Caules fasciculati, superpositi, cylindracei, graciles, saepissime laxe ramosi. Folia in caulium apice duo subopposita, lineari-oblonga vel lineari-lanceolata, apice oblique bilobulata, sessilia. Inflorescentiae abbreviatae, dense fasciculatae, uniflorae. Flores perparvi, membranacei. Sepalum dorsale oblongum, valde concavum, subacutum. Sepala lateralia similia, paulo majora. Petala lineari-oblanceolata, apice rotundato minute apiculata, sepalum dorsale vix aequantia. Labellum in positu naturali tubulari-concavum, expansum rhombico-obovatum, medio lobulato-dilatatum, apice rotundato minute apiculato. Columna recta, exalata.

Plant large, straggling, epiphytic. Rhizome abbreviated. Roots fibrous, glabrous, long, slender, situated at base of plant and also at base of stem-members. Stems fascicled, superposed, slenderly cylindric, usually loosely

branching above, with the stem-members concealed below by several close, imbricating, scarious sheaths, the lowest stem-member up to 18 cm. long. Leaves in subopposite pairs at the apex of the stem-members, linear-oblong or linear-lanceolate, rather gradually narrowed to an obliquely bilobulate apex, slightly narrowed to a sessile base, spreading, up to 10 cm. long and 1 cm. wide. Inflorescences abbreviated, densely clustered in the axils of the leaves at the summit of the stem-members, 1-flowered, numerous. Flowers very small, pinkish white to white, membranaceous. Dorsal sepal oblong, subacute, deeply concave, about 3.7 mm. long and 1.2 mm. wide. Lateral sepals similar, forming an indistinct mentum with the column-foot, about 3.9 mm. long and 1.3 mm. wide. Petals linear-oblanceolate, minutely apiculate at the rounded apex, slightly oblique, nearly as long as the dorsal sepal. Lip erect and subparallel to the column, with incurved sides in natural position, about 3.8 mm. long, rhombic-obovate in outline when expanded, lobulate-dilated in the middle with indistinct rounded lateral lobules, broadly rounded and minutely apiculate in front, about 2 mm. wide across the middle when expanded. Column stout, straight, wingless, about 2.9 mm. long, extended into a very short foot.

This species is very similar to *Scaphyglottis leucantha* Reichb.f. vegetatively, but has a very different lip. Among the South American members of the genus, this plant has relatively short, broad leaves.

PERU: JUNÍN; Pichis Trail, San Nicholas, at about 1100 meters altitude, epiphyte in dense forest, July 4–5, 1929, *E. P. Killip & A. C. Smith 26061* (TYPE in Herb. Ames No. 61413; ISOTYPE in Herb. Field Mus. No. 622159).

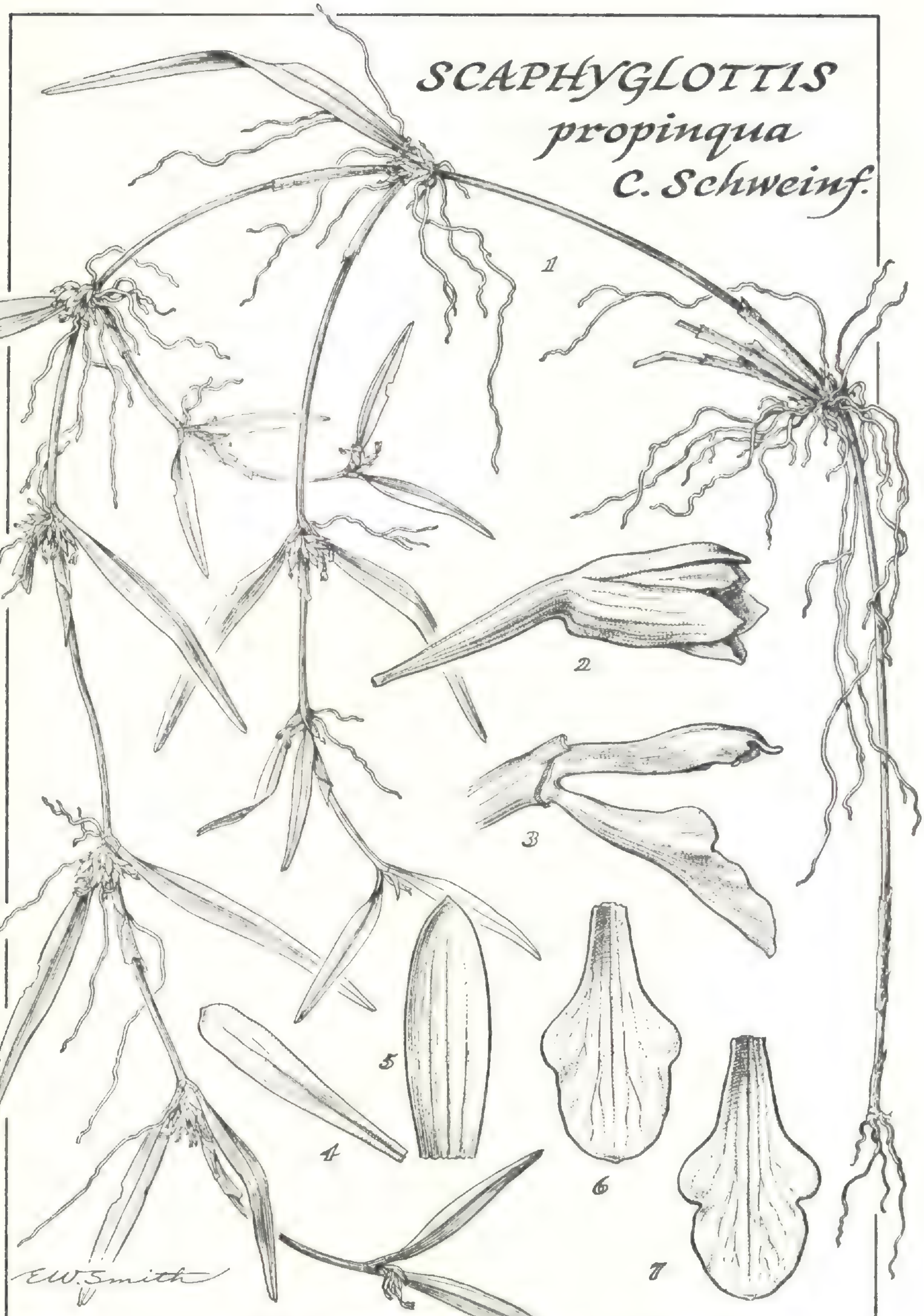
Scaphyglottis punctulata (*Reichb.f.*) *C. Schweinfurth comb. nov.*

Ponera punctulata Reichenbach filius in Bonpl. 3 (1855) 220.

EXPLANATION OF THE ILLUSTRATION

PLATE XVIII. SCAPHYGLOTTIS PROPINQUA *C. Schweinf.* 1, plant, one half natural size. 2, flower from side, natural position, six times natural size. 3, column and lip from side, natural position, about nine times natural size. 4, petal, about nine times natural size. 5, dorsal sepal, about nine times natural size. 6, 7, lips expanded, about nine times natural size.

Drawn by ELMER W. SMITH


SCAPHYGLOTTIS
propinqua
C. Schweinf.
1
2
3
4
5
6
7
E.W. Smith

Records of *Ponera punctulata* from the Reichenbach Herbarium in Vienna show that this concept is clearly referable to the genus *Scaphyglottis* Poepp. & Endl. It has the relatively elongate, apically biauriculate column that is characteristic of the genus, rather than the abbreviated exauriculate column of *Ponera*. Moreover, it shows that the two apical leaves are subopposite as in *Scaphyglottis*, and they are borne at some distance from the lower distichous leaves, although not so far remote as is common in the latter genus.

Three collections from Peru and one from Puerto Rico are referred to this concept. All of these collections, as well as the typical *Ponera punctulata* from Venezuela, have distichously leafy stems, although the lower portions bear only imbricating, leaf-bearing sheaths.

In order to clarify this little known species, the following diagnosis is given, based chiefly on the Peruvian and Puerto Rican collections.

Plant terrestrial in moss or epiphytic, caespitose, up to 52 cm. high to the tip of the uppermost leaf. Stems distichously leafy, for the most part entirely concealed by imbricating leaf-sheaths, either simple or with one to three short branches (when with only a single branch, appearing to have one continuous axis), the uppermost portion naked, short and terminated by a pair of subopposite leaves, up to about 43 cm. high. Leaves erect-spreading, linear to linear-lanceolate, up to 12.9 cm. long and 9 mm. wide (often much smaller, especially below), gradually narrowed to an obtuse or bilobulate apex, clasping at base. Inflorescence terminal on the stem or branches, abbreviated, racemose, 1- or more commonly 2-flowered, issuing from a pair of erect, imbricating, evanescent spathes. Pedicellate ovary long and slender, 1.6 cm. or more in length (up to 3.5 cm. long including the ripened ovary). Flowers rather small, campanulate,

lavender tinged with green, or green dotted with pink or dark violet and a greenish white lip. Dorsal sepal ovate-oblong, concave, acute or short-acuminate, about 7–9 mm. long and 3–4 mm. wide. Lateral sepals obliquely lanceolate-ovate, acute or short-acuminate, about 7–8.7 mm. long and 2.8–4 mm. wide near the base which is decurrent on the column-foot. Petals lanceolate-oblong or elliptic-oblong, more or less oblique, abruptly subacute to acute or apiculate, 6.1–8.9 mm. long, 2–3 mm. wide. Lip slightly exceeding the sepals, articulated to the column-foot without a claw, obovate-pandurate in outline with a cuneate base, either truncate or very broadly rounded and apiculate or lightly retuse and apiculate in front, arcuate-recurved below, with more or less incurved sides, about 7–8.5 mm. long when expanded and 3.4–6.3 mm. wide across the apical portion; disc below with a more or less prominent, large, fleshy, concave or sulcate callus which is extended into verruculose lines above. Column conspicuous, arcuate, prominently auriculate-dilated at the apex, about 5–6.6 mm. long, produced into a short foot.

Puerto Rico: El Yungue, on trees near summit of Mt. Britton, in fruit, June 22, 1952 (flowered in greenhouse March 30, 1953), *D.S. Correll & H. F. Winters s.n.*

Venezuela: *Geitner s.n.* (type of *Ponera punctulata*).

Peru: Huánuco, Cierra Azul, on Pucallpa Road, at 3500 feet altitude, in road cut, terrestrial in moss, December 1, 1945, flower "lavender tinged green," *R.J. Seibert 2252.*—Junín: Pichis Trail, Eneñas, at 1700 meters altitude, epiphyte in open sphagnum swamp, July 1, 1929, *E. P. Killip & A. C. Smith 25675, 25690.*

Scaphyglottis punctulata (*Reichb.f.*) *C. Schweinf.* var. **Summersii** (*L. O. Wms.*) *C. Schweinfurth comb. nov.*

Scaphyglottis Summersii L. O. Williams in Bot. Mus. Leafl. Harvard Univ. 9 (1940) 14, t. 3, figs. 4–7.

After careful study, I have concluded that the plant

described as *Scaphyglottis Summersii* cannot be considered as specifically distinct from the species that was first published as *Ponera punctulata*. There are, however, several discrepancies between the two concepts which make a varietal separation seem advisable.

In the first place, *Scaphyglottis Summersii* commonly presents a very different vegetative appearance from *S. punctulata*. It usually has much branched stems, with the upper portion of the stem-members commonly conspicuously surpassing the uppermost leaf-sheath, whereas *S. punctulata* has simple or few-branched stems which are distichously leafy with only the uppermost part emerging as a short, naked portion above the upper leaf-sheath.

There are also marked differences in the flowers. The lip of *S. Summersii* always seems to have a short but distinct claw, and the base of the lamina is more or less rounded to subcordate, whereas the lip of the species has a sessile cuneate base. Finally, the column of *S. Summersii* is always shorter than that of *S. punctulata*.

This concept, as *Scaphyglottis Summersii*, was first described from Ecuador, but it has been subsequently detected from Colombia, Peru and Bolivia.

Polystachya nana (*Poepp. & Endl.*) *Reichenbach filius* in Walp. Ann. 6 (1863) 638.—Cogniaux in Martius Fl. Bras. 3, pt. 4 (1896) 319.

Encyclia nana Poeppig & Endlicher Nov. Gen. ac Sp. 2 (1837) 10, t. 113A.

Encyclia polystachya Poeppig & Endlicher Nov. Gen. ac Sp. 2 (1837) 10, t. 113B.

Stelis foliosa Lindley in Ann. & Mag. Nat. Hist. 2 (1839) 330, t. 17.

Polystachya cerea Lindley in Bot. Reg. 26 (1840) Misc. p. 86, no. 208.

Polystachya clavata Lindley in Bot. Reg. 28 (1842) Misc. p. 61., no. 71.
Polystachya Weigeltii Reichenbach filius in Linnaea 25 (1852) 230.
Polystachya nana Klotzsch in Ind. Sem. Hort. Berol. (1853) N. 5, *nomen.*
Polystachya caracasana Reichenbach filius in Bonpl. 2 (1854) 15.
Polystachya foliosa Reichenbach filius in Walp. Ann. 6 (1863) 640.—Cogniaux in Martius Fl. Bras. 3, pt. 4 (1895) 316.
Polystachya minor Fawcett & Rendle in Journ. Bot. 48 (1910) 106; Fl. Jam. 1 (1910) 49, t. 7, figs. 6–7.
Polystachya altilamellata Schlechter in Fedde Repert. 10 (1912) 385.
Polystachya ecuadorensis Schlechter in Fedde Repert. Beih. 8 (May 1921) 90; in Fedde Repert. Beih. 57 (1929) t. 95, nr. 370.
Polystachya Poeppigii Schlechter in Fedde Repert. Beih. 9 (Sept. 1921) 155.
Polystachya cubensis Schlechter in Urban Symb. Antill. 9 (1923) 59.
Polystachya amazonica Schlechter in Beih. Bot. Centralbl. 42, Abt. 2 (1925) 77; in Fedde Repert. Beih. 58 (1930) t. 47, nr. 186.
Polystachya Huebneri Schlechter l.c., 112.
Polystachya stenophylla Schlechter l.c. 113.

Prolonged study of collections of Polystachya from the American tropics, following years of varied and changing determinations, has convinced me that the characters heretofore used for specific separation are highly variable and indecisive and that such classic treatments as that of Cogniaux in Martius, Flora Brasiliensis are untenable. Strange as it may seem, it was the vegetative features (that are known to be extremely incon-

stant) which usually formed the major key to separation, and investigation shows these characters to be wholly unreliable. For instance, the size of the plant, the width of the leaves, the relation of the height of the inflorescence to that of the leaves, and the racemose or paniculate form of the inflorescence were erroneously considered to be of great weight. Contributary marks of distinction were taken in the size and termination of the floral segments and in the exact form of the petals and lip.

I have come to the conclusion, concurred in by that astute student of orchidology, Mr. Leslie Garay of Toronto, Canada, that Polystachya takes its place among such strikingly polymorphic groups as Epidendrum, Spiranthes and Habenaria. As a consequence, it has seemed advisable in the interests of truth and simplicity, to make the above reductions, now that an abundance of material is available.

Mr. Garay points out that his "microfilm copy of Poeppig's Nova Genera bears a pencil mark of unknown origin which indicates that on plate 113 the habit sketch B (*Encyclia polystachya*) and the details A belong together [contrary to the citation], also the habit sketch A and the details B." Indeed this interpretation proves to be true, judging from Cogniaux' description of *Polystachya nana* in Martius Flora Brasiliensis, Vol. 3, pt. 4 (1896) 319, after his having seen the Poeppig type of *Encyclia nana*. However, his description of the lip of *Encyclia nana* agrees well with the drawing of the lip of *Encyclia polystachya*.

After making allowance for the well-authenticated fact that the mid-lobe of the lip of this group of Polystachya is often slightly retuse at the broadly rounded apex, it appears certain that the concepts *Stelis foliosa* Lindl., *Polystachya cerea* Lindl., *Polystachya clavata* Lindl., and *Polystachya caracasana* Reichb.f. (all represented in the

Ames Herbarium and accompanying library by drawings of the type) are inseparable from our basic concept.

Polystachya Weigeltii Reichb.f., described with a retuse mid-lobe of the lip, was reduced to *P. foliosa* by Reichenbach filius in his type diagnosis of the latter species, while that great orchidologist considered *P. nana* Kl. referable to *P. caracasana* Reichb.f.

Polystachya minor Fawc. & Rendle has already been shown to represent *P. cerea* Lindl.

It is evident both from an excellent photograph of the type and from the diagnosis that *Polystachya altilamellata* Schltr. is only a narrow-leaved form of this variable species. In this form, the mid-lobe of the lip is described as suborbicular, as seen in the type drawing of that organ in *P. caracasana* Reichb.f.

Polystachya ecuadorensis Schltr. seems, judging from the description and from the floral analysis, to represent a concept closely similar to the usually broad-leaved species with the quadrate mid-lobe of the lip shown by *Polystachya minor* Fawc. & Rendle.

Judging from a photograph of the type and the original description, *Polystachya cubensis* Schltr., represents a plant inseparable from *P. minor* Fawc. & Rendle, with somewhat longer and narrower leaves.

It appears that *Polystachya amazonica* Schltr. represents the small form exemplified by *Stelis foliosa* Lindl., but it seems to have the ovate-oblong dorsal sepal and the subquadrate mid-lobe of the lip seen in *Polystachya minor* Fawc. & Rendle.

Polystachya Huebneri Schltr. and *P. stenophylla* Schltr., both narrow-leaved species, are in other characters very similar to *P. minor* Fawc. & Rendle. In *P. Huebneri*, the inflorescence is described as commonly little surpassing the leaves, and the flowers appear to be very close to those shown in the type of *Stelis foliosa*

Lindl., but with the subquadrate mid-lobe of the lip seen in *P. minor*. *P. stenophylla* has even narrower leaves than *P. Huebneri*, but the panicle is described as always shorter than the leaves and the larger flowers appear to be similar to those of *P. minor*.

This extremely polymorphic species extends from Mexico (*P. cerea*), through Central America (*P. clavata*, *P. guatemalensis*, *P. panamensis*), through the West Indies (*P. minor*, *P. cubensis*) to South America (*Stelis foliosa*, *Encyclia nana*, *Encyclia polystachya*, *P. Weigeltii*, *P. altilamellata*, *P. ecuadorensis*, *P. amazonica*, *P. Huebneri* and *P. stenophylla*).

Warrea Warreana (*Lodd. ex Lindl.*) *C. Schweinfurth comb. nov.*

Maxillaria Warreana Loddiges ex Lindley Gen. & Sp. Orch. (1832) 148.—Loddiges Bot. Cab. (1833) t. 1884.—Hooker in Bot. Mag. 72 (1846) t. 4235.

Warrea tricolor Lindley in Bot. Reg. 29 (1843) Misc. p. 14.—Cogniaux in Martius Fl. Bras. 3, pt. 5 (1901) 376, t. 81.

Warrea speciosa Schlechter in Fedde Repert. Beih. 9 (1921) 98; in Fedde Repert. Beih. 57 (1929) t. 123, nr. 483.

It has been pointed out by Cogniaux (l.c.) that *Warrea tricolor* represents the plant depicted as *Maxillaria Warreana*.

The concept described and figured as *Warrea speciosa* seems to be surely referable to the same species.

According to strict adherence to the rule of priority, it becomes necessary to make the above combination.

Maxillaria attenuata *Ames & Schweinfurth* in Sched. Orch. 10 (1930) 89.

The occurrence in South America of this Costa Rican species with markedly longer leaves and flowers than

formerly attributed to this concept makes advisable the following redescription:

Plant small, caespitose, up to 10 cm. high. Pseudobulbs complanate, ovoid to ellipsoid, about 1 cm. high, unifoliate, finely rugose in the dried specimen, clothed at the base with two pairs of sheaths, the upper being larger and leaf-bearing. Leaves with more or less conspicuous petioles, up to 9.4 cm. long; lamina elliptic to oblong, acute, cuneate below, up to 8 cm. long and 1.4 cm. wide. Inflorescence subequaling or surpassing the leaves, spreading, 1-flowered; peduncle mostly concealed by several loose, tubular sheaths of which the lower are successively smaller and imbricated. Flower large for the plant, membranaceous and nervose. Dorsal sepal linear-lanceolate or linear-triangular, long-acuminate, 1.8–2.6 cm. long, 4–4.6 mm. wide across the concave base. Lateral sepals linear-triangular to narrowly triangular-lanceolate, oblique, slightly longer and noticeably broader than the dorsal sepal, forming a conspicuous mentum at the base. Petals similar to the lateral sepals, but markedly smaller. Lip erect, parallel to the column and lightly recurved in natural position, more or less sharply 3-lobed in the middle, elliptic-lanceolate to ovate-lanceolate in outline when expanded, about 1.5–1.8 cm. long, 5–9 mm. wide; mid-lobe triangular-lanceolate to ovate-lanceolate, dorsally keeled and mucronate at the apex; disc with a more or less pronounced median, longitudinal callus. Column short and stout, 4–5 mm. high at the back, extended into a slightly longer foot.

Venezuela: State of Bolívar, Ptari-tepuí, on densely forested, steep, south-facing slopes overlying sandstone, between "Cave Rock" and the base of high sandstone bluffs, 2100–2285 meters altitude, flower brown and yellow, October 30, 1944, *Julian A. Steyermark 59359*.

Peru: Cuzco; Province of Paucartambo, Santa Isabel to Asunción, epiphyte at 1800 meters altitude, flower wine-red, January 4, 1946, *C. Vargas 5536*.

Lockhartia hologlossa *Schlechter* in Fedde Repert. Beih. 7 (1920) 199; in Fedde Repert. Beih. 57 (1929) t. 71, nr. 274.

Lockhartia unicornis Schlechter in Fedde Repert. Beih. 7 (1920) 200; in Fedde Repert. Beih. 57 (1929) t. 71, nr. 275.

A critical examination of the descriptions of these Colombian concepts, amplified by the floral analyses cited above, indicate that they should be considered conspecific.

According to the descriptions, there is a considerable discrepancy between the small flowers of *Lockhartia hologlossa* and the relatively large flowers of *L. unicornis*. However, as often noted in the case of many tropical orchids, there is a wide range in the size of the flowers of one species during the course of development. Accordingly, a separation which depends chiefly on size is apt to be unwarranted. Furthermore, the morphological characters of the floral parts of the two species are closely similar and surely not worthy of specific separation.

Two recently studied collections from the Department of Cuzco, Peru, appear to be referable to this variable species. While they show wide variation in vegetative size, the sepals and petals of both collections are intermediate in size between those of *L. hologlossa* and *L. unicornis*.

PERU: Cuzco; Prov. of Quispicanchis, Ttío to Murayaca, Marcapata, at 1960 meters altitude, on rocks, perianth yellow, January 28, 1943, *C. Vargas 3138*.—Prov. of Urubamba, Machu-Picchu, at 2020 meters altitude, on rock, flower yellow, January 4–5, 1946, *Vargas 5546*.

Telipogon Hercules *Reichenbach filius ex Kränzlin* in Ann. Naturh. Hofmus. Wien 33 (1919) 27.

In the Ames Herbarium there is a specimen bearing the label "Telipogon Hercules Rb. f. Pueblo-Laguna Columbia: Bei Pasto. 1500′ lg. Lehmann Typus!" This collection, which has the same general facies and floral

measurements of the description and is cited after the description in the position of a cotype, must be considered as truly representing this concept. It shows, however, certain marked discrepancies from the description, and it appears that these characters should be noted.

The longest leaf measures 9 cm. in length, whereas the description gives the maximum length as 10 cm. The peduncle with the rachis of the raceme is about 16 cm. high, whereas the diagnosis gives a height of 25–33 cm. and it appears more or less angulate rather than terete. The most important discrepancy seems to exist in the veining of the petals and lip—a character which is very generally considered of major importance in separating the species of the genus Telipogon. The petals of this collection are 13-nerved (not 19-nerved), and the lip is only 17-nerved (not 29-nerved). Moreover, both the petals and lip bear numerous, though indistinct, oblique cross-reticulations which are not described.

Trichoceros muralis *Lindl.* var. **platyceros** *(Reichb.f.) C. Schweinfurth comb. nov.*

Trichoceros platyceros Reichenbach filius in Xen. Orch. 1 (1854) 22, t. 9, fig. III.

This concept, which was described from a single flower, was said to differ from *T. muralis* by having the dorsal sepal shorter than the lateral sepals, by having the base of the lip ecallose and by having the lateral lobes of the lip semiovate from a clawed base, rather than linear or oblong.

Actually the shorter appearance of the dorsal sepal was in part caused, as Reichenbach says (l.c.), by its cucullate character, so that there seems to be little difference in length when this organ is expanded.

In the Ames Herbarium there are two collections, one from Ecuador and one from Peru, which have the short

semiovate or oblong-obovate lateral lobes of the lip like *T. platyceros*, but the center of the disc at the base is marked by a distinct fleshy, pilose callus as in *T. muralis*.

It appears to me the wiser course, as was indicated by Lindley on the sheet bearing the type collection of *T. muralis*, to consider *T. platyceros* as a variant of *T. muralis*.

Since this concept lacks any vegetative description, it seems desirable to give a rather complete diagnosis as follows:

Plant small to medium-sized, epiphytic. Roots fibrous, stout, glabrous. Rhizome creeping, more or less concealed by close, tubular sheaths. Pseudobulbs small, broadly ovoid, mostly concealed by sheaths or the bases of the imbricating leaves. Leaves two or three, clustered at the base of the stems, suborbicular to elliptic-oblong, sessile at the clasping base, prominently apiculate, up to about 4 cm. long and 1.4 cm. wide, coriaceous. Stems up to 15.5 cm. high with a slender, filiform peduncle provided by several (two or three) short, infundibuliform sheaths. Raceme short, loosely up to 7-flowered. Flowers rather small, with spreading segments. Dorsal sepal cucullate, ovate-elliptic, acute, apiculate, 8–16 mm. long, up to 9 mm. wide. Lateral sepals similar, sometimes slightly longer. Petals similar to the sepals, but sometimes slightly broader, ciliolate throughout. Lip about equaling the other segments, 3-lobed at the base, up to 15 mm. long; lateral lobes relatively small, obliquely semiovate to oblong-obovate, rounded-obtuse; mid-lobe relatively large, obovate or oblong-obovate, rounded at the apex with sometimes a minute apicule; disc more or less pilose throughout. Column minute, densely setose.

ECUADOR: near Loja, *Warscewicz s.n.* (type).—Province of Azuay, Cuenca, 2600 meters altitude, July 16, 1939, *C. William Penland & Robert H. Summers 1054.*

PERU: Department of Ancash, Province of Bolognesi, Chupa, mountain near Aquia, 3200–3250 meters altitude, on stony soil, "rojo oscuras," called "michimichi," May 18, 1950, *Ramon Ferreyra 7546*.

Trichoceros parviflorus *Humboldt, Bonpland & Kunth* Nov. Gen. & Sp. 1 (1816) 337, t. 76.—Lindley Gen. & Sp. Orch. (1833) 174. Reichenbach filius in Xen. Orch. 1 (1854) 21, t. 9, figs. I; II, 1–6.

Trichoceros armillatus Reichenbach filius in Bonpl. 4 (1856) 212; in Xen. Orch. 1 (1858) 231, t. 97, fig. V.

Trichoceros muscifer (as *muscifera*) Kränzlin in Engler Bot. Jahrb. 37 (1906) 387.

As was pointed out by Reichenbach filius (in Walp. Ann. 3 (1852) 563, sub Hofmeisterella) the organs which were described and illustrated as antenna-like processes of the column in *Trichoceros parviflorus*, the type of its genus, do not belong to the column, but are in reality lateral lobes of the lip.

The concept *Trichoceros armillatus* is said to vary from the allied *T. parviflorus* by having the mid-lobe of the lip somewhat calceolate or lightly concave, a character which is indicated in the illustration. Furthermore, the sepals are described as carinate without; the species is relatively small and bears only three flowers.

Whereas the lip of *T. parviflorus*, in the numerous collections of that widespread species, is generally flat or even convex, in occasional specimens the lip has the lateral margins more or less involute, particularly in the freshly opened flowers, and thus a lightly concave condition prevails. Also, the lateral sepals of *T. parviflorus* seem to be sometimes more or less carinate.

It appears reasonable, therefore, to regard *T. armillatus* as referable to the variable *T. parviflorus*, of which small, few-flowered forms are seen intermixed with the larger plants.

The plant described as *Trichoceros muscifer* was al-

leged to be distinct from the related *T. parviflorus* by reason of the bristle-like setae on the column and at the base of the lip. However, a similar area of bristle-like hairs appears on the column and on the lip of specimens referable to *T. parviflorus*, and a wide range of variability in degree and prominence of the hairs is evident on the lip of various collections referable to that species. Moreover, an excellent photograph of *T. muscifer* bearing a floral analysis does not show any appreciable disparity from a Bolivian collection (*Mandon 1149*) determined by Reichenbach filius as exemplifying *T. parviflorus* and from several Peruvian collections lately determined as representing the latter species. It is noteworthy that the sepals and petals of *T. muscifer* are described as obtuse, whereas the analysis shows them to be acute or acuminate.

A peculiarity of this species is that the basal part of the lip occasionally bears a more or less marked, central, longitudinal fleshy ridge or thickening, sometimes resembling a keel. In one flower of *T. parviflorus* from Bolivia (*Mandon 1149*) such a keel is evident on the basal portion of the lip of one flower, while a bud from that same collection shows a lip that is quite ecarinate or ecallose, thus indicating a variable condition.

As now understood, *Trichoceros parviflorus* extends from Colombia (type), Ecuador and Peru to Bolivia.

Dichaea pendula (*Aubl.*) *Cogniaux* in Urban Symb. Antill. 4 (1903) 182, 6 (1910) 670; in Martius Fl. Bras. 3, pt. 6 (1906) 486, t. 102, fig. 1, *excl. synon. in part.*

Limodorum pendulum Aublet Pl. Guian. 2 (1775) 819, t. 322.

Dichaea echinocarpa Lindley Gen. & Sp. Orch. (1833) 208, non *Epidendrum echinocarpon* Swartz nec *Cymbidium echinocarpon* Swartz.

Dichaea echinocarpa (Sw.) Lindley var. *lobata* Ames

& Correll in Bot. Mus. Leafl. Harvard Univ. 11 (1943) 71, t. 4, fig. 2 (p. 70).

This concept, according to Aublet's description and to the interpretation of Cogniaux, is characterized by a definitely 3-lobed or sagittate lip. It is chiefly limited to the West Indies and to South America (Venezuela, Guiana and Brazil), but, as *D. echinocarpa* var. *lobata* is recorded from Costa Rica.

Dichaea pendula (*Aubl.*) *Cogn.* var. **Swartzii** *C. Schweinfurth var. nov.*

Epidendrum echinocarpon Swartz Prodr. Veg. Ind. Occ. (1788) 124.

Cymbidium echinocarpon Swartz in Nov. Act. Upsal. 6 (1799) 71; Fl. Ind. Occ. 3 (1806) 1452, *excl. synon. in part.*

Dichaea echinocarpa Lindley, sensu Fawcett & Rendle in Fl. Jam. 1 (1910) 136, t. 30, figs. 26–30.

Fawcett and Rendle point out that the Jamaican specimens of *Dichaea echinocarpa* have an entire lip which is merely angulate above, and this concept was first described as *Epidendrum echinocarpon* and *Cymbidium echinocarpon* by Swartz.

The plant characterized by the simple, merely angulate lip without any definite lateral lobes appears to be confined to the West Indies and to Costa Rica and to constitute a distinct variety.

Epidendrum echinocarpon, however, which was published by Swartz without any floral characterization, is an illegitimate name, for it should have borne the epithet *pendulum* following the citation in synonymy of *Limodorum pendulum*. Therefore, the name must be eliminated from consideration, even in a varietal category.

Centropetalum distichum *Lindley* Sert. Orch. (1838) sub t. 21; in Benth. Pl. Hartweg. (1844) 150.—

Reichenbach filius in Xen. Orch. 1 (1855) 96.—Kränzlin in Engler Pflanzenr. IV. 50 (Heft 83) (1923) 30.

Centropetalum Warscewiczii Reichenbach filius in Bot. Zeit. 10 (1852) 706; in Xen. Orch. 1 (1855) 96, t. 38, fig. I, 1–5.

Fernandezia disticha (Lindl.) Schlechter in Fedde Repert. 16 (1920) 349.

Fernandezia Warscewiczii Schlechter l.c.

Fernandezia pulchra Schlechter in Fedde Repert. Beih. 9 (1921) 117; in Beih. 57 (1929) t. 131, nr. 513.

On the evidence of the descriptions of *Centropetalum Warscewiczii* combined with the analytical drawing cited, it appears that this concept cannot reasonably be separated from the earlier *C. distichum* which is represented in the Gray Herbarium by authentic material and in the Ames Herbarium by a photograph of the type with floral analyses. Indeed, the only discrepancies to be found are that the lip of *C. Warscewiczii* is lightly retuse in contrast to the entire (or denticulate) apex of this organ in *C. distichum*, and the color of the flowers which is designated as purple or blood-red in *C. Warscewiczii*, as contrasted with yellow or orange-yellow in *C. distichum*. On the sheet bearing the photograph of typical *C. distichum*, however, there is one lip (of an Ecuadorian plant) showing a similarly retuse lip. Thus the slight discrepancy in color appears to be the only remaining difference.

The name *Fernandezia* must be considered to be invalid, because this genus (as illustrated in Ruiz & Pavon Fl. Peruv. et Chil. Prodromus (1797) t. 27, Fernandezia) comprises at least two different genera.

In describing the concept *Fernandezia pulchra* (l.c.) Schlechter says that it differs from *Centropetalum distichum* in having larger flowers of different color, in the form of the lip and its callus and in the toothed and 3-lobed clinandrium. However, the photograph of typi-

cal *C. distichum* previously mentioned shows one flower quite as large as that of *Fernandezia pulchra*, and the form of the lip appears to be substantially similar in the two concepts. Moreover, the 3-lobed and toothed clinandrium in *Fernandezia pulchra* is shown also in the analysis of *Centropetalum distichum* as drawn on the sheet bearing the type specimens. Accordingly, the only discrepancies between these two concepts consist in minor differences in the color of the flowers and in slight discrepancies in the callus on the lip.

It seems to me, therefore, that all of these concepts should be treated as representing a single variable species.

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PLANTAE COLOMBIANAE XIII

DE PLANTIS PRINCIPALITER COLOMBIAE AMAZONICAE NOTAE DIVERSAE SIGNIFICANTES

BY

RICHARD EVANS SCHULTES

As more and more collections of plants from northwestern South America are studied, our knowledge of the distribution of many of the poorly understood genera and species increases apace. Occasionally, undescribed concepts are found. In addition, ethnobotanical information of considerable interest often is made available through the field studies connected with the collections under study. This paper is a continuation of a series devoted to the publication of such miscellaneous data.

It is a pleasure to acknowledge the collaboration of Dr. Lyman B. Smith of the Smithsonian Institution, who is responsible for the work on the *Bromeliaceae;* of Mr. Noel Y. Sandwith of the Royal Botanic Gardens, Kew, who has described a new concept in the *Bignoniaceae;* of Dr. Harold N. Moldenke of the Trailside Museum, New Jersey, who has identified the *Eriocaulaceae;* of Dr. Alicia Lourteig of the Musée d'Histoire Naturelle, Paris, who determined *Cuphea;* and of Dr. Julian A. Steyermark of the Chicago Museum of Natural History and Dr. José Cuatrecasas of the National Science Foundation, who have contributed studies in several genera.

The families are arranged in conformity with the system proposed by Engler and Gilg.

Paepalanthus polytrichoides *Kunth* var. **glaber** *Moldenke var. nov.*

Haec varietas a *Paepalantho polytrichoide* principaliter foliis brevioribus atque pedunculis glabris differt.

COLOMBIA: Comisaría del Vaupés, Río Karurú (tributary of Río Vaupés), Mesa de Yambí, Savannah Goo-ran-hoo-da. General location: Lat. 1°20′ N, Long. 71°20′ W. April 15–16, 1953, *Richard Evans Schultes & Isidoro Cabrera 19180* (TYPE in N.Y. Bot. Gard.).

Paepalanthus saxicola *Körnicke* in Martius Fl. Bras. 3, pt. 1 (1863) 455.

The type of *Paepalanthus saxicola* was collected in Goyáz in Brazil. The collection cited below very greatly extends the known range of this species.

COLOMBIA: Comisaría del Amazonas, Río Caquetá, Araracuara. December 21, 1952, *Hernando García-Barriga & Richard Evans Schultes 14138.*

Paepalanthus Williamsii *Moldenke* in Phytol. 2 (1947) 367.

Known hitherto from the upper Orinoco basin of Venezuela and from the Estado do Amazonas in Brazil, this species is now recorded from Colombia through the collection cited below.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá, savannahs about 15 miles upstream from mouth. November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18383.*

Syngonanthus longipes *Gleason* in Bull. Torr. Bot. Club 56 (1929) 15.

Syngonanthus longipes, a characteristic though never abundant element of the savannah floras of the Vaupés, is known also from the Amazonas and Bolívar of Venezuela, from British Guiana and from the Guaporé of Brazil.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá, savannahs about 15 miles upstream from

mouth. Alt. 800–900 feet. November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18360.*

Thurniaceae

Thurnia sphaerocephala (*Rudge*) *Hooker fil.* in Hooker Icon. Pl. (1883) t. 1407.

These collections of *Thurnia sphaerocephala*, in addition to those already reported (Schultes in Bot. Mus. Leafl. Harvard Univ. 16 (1954) 189), indicate that the species is not an uncommon element of the flora of the Colombian Vaupés.

Colombia: Comisaría del Vaupés, Río Kananarí, Cachivera Palito. Alt. ca. 250 m. July 25, 1951, *Richard Evans Schultes & Isidoro Cabrera 13194.*—Comisaría del Vaupés, Río Piraparaná, Raudal Guá-kö-nö-ta. September 4, 1952, *Schultes & Cabrera 17166.*—Comisaría del Vaupés, Río Piraparaná (tributary of Río Apaporis) Caño Teemeeña. General location: between Lat. 0°15′ S, Long. 70°30′ W and Lat. 0°25′ N, Long. 70°20′ W. "In flowing water." September 6, 1952, *Schultes & Cabrera 17259.*

Bromeliaceae

(Contributed by Lyman B. Smith)

Pitcairnia corallina *Linden & André* var. **viridis** *L. B. Smith var. nov.*

A var. *corallina* laminis foliorum angustioribus inflorescentia flavo-viridi differt.

Leaf-blades only 3 cm. wide; inflorescence yellow-green.

Colombia: Comisaría del Vaupés, Río Vaupés: Circasia. Sandy savannah, quartzite base. Alt. ca. 240 m. Lat. 0°45′ N, Long. 70°30′ W. April 20, 1953, *Richard Evans Schultes & Isidoro Cabrera 19206* (Type in U. S. Nat. Herb. Nos. 2087662 and 2087663).

Pitcairnia patentiflora *L. B. Smith* in Contrib. Gray Herb. 127 (1939) 18, t. 1, fig. 4.

The Colombian material of this species shows such diversity that it seems advisable to divide it into varieties as follows:

var. **patentiflora**

Plant 0.5–1 m. high; leaf-blades scarcely or not at all narrowed toward the base, 3–15 mm. wide, serrate for most of their length with spines 2 mm. long; sepals 15–20 mm. long.

The type of the species is from Venezuela. Other material from Venezuela and Amazonian Brazil shows little variation from it.

Colombia: Comisaría del Vaupés, near Cerro Monachí, Río Naquieni, Río Guainía basin, June 1948, *Richard Evans Schultes & Francisco López 10082.*

var. **subintegra** *L. B. Smith var. nov.*

Laminis foliorum ad basin distincte angustatis, ad 20 mm. latis, basi excepta integris, sepalis 13–18 mm. longis differt.

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. October 29, 1951, *Richard Evans Schultes & Isidoro Cabrera 14532* (Type in U.S. Nat. Herb. No. 2087660).—Comisaría del Vaupés, Río Macaya, Cerro Chiribiquete, January 17, 1944, *G. Gutiérrez 672.*—Comisaría del Vaupés, Cerro Yapobodá, Río Kuduyarí. On quartzite rocks, savannah. Alt. 450 m. October 5, 1951, *Schultes & Cabrera 14214.*—Comisaría del Vaupés, near headwaters of Río Kuduyarí (tributary of Río Vaupés). Quartzite savannah. Alt. 270–300 m. Lat. 1°20′ N, Long. 70°30′ W. April 1953, *Schultes & Cabrera 20009.*

var. **macrantha** *L. B. Smith var. nov.*

Planta ad 2 m. alta, laminis foliorum ad basin distincte angustatis, ad 25 mm. latis, basi excepta integris, sepalis 25 mm. longis differt.

Colombia: Comisaría del Vaupés, Río Macaya, Cerro Chiribiquete. Sandstone ledges. Alt. 630 m. July 24, 1943, *Richard Evans Schultes 5613* (Type in U.S. Nat. Herb. Nos. 1902474 and 1989361).

Pitcairnia turbinella *L. B. Smith* in Caldasia 1, no. 4 (1942) 18, t. 5.

Described from Circasia, on the Río Vaupés, and from San José, on the Río Guaviare, *Pitcairnia turbinella* is

apparently an element peculiar to the sandstone mountains of the Venezuela-Guiana land-mass. It is especially abundant on the sun-baked summit of Cerro Ee-ree-ee-kö-mee-ö-kee, where the habit photograph published herewith was taken.

Colombia: Comisaría del Vaupés, Río Piraparaná, Raudal Mö-kö, Cerro Ee-ree-ee-kö-mee-ö-kee. "Flowers deep red, covered with grey pulverulence. Fruit dark green. Inflorescence up to 10 feet tall. On bare rock. Leaves yellow inside at base, rest green." September 18, 1952, *Richard Evans Schultes & Isidoro Cabrera 17532.*

Brocchinia acuminata *L. B. Smith* in Brittonia 3 (1939) 160, f. 3 a–d.

This species was described originally from Mount Auyan-tepuí in southeastern Venezuela. Steyermark extended its known range in Venezuela eastward to Ptarí-tepuí, and Maguire westward to Cerro Guaiquinima, while the collections noted below record its appearance in Colombia making a total range of over 700 miles.

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. October 29, 1951, *Richard Evans Schultes & Isidoro Cabrera 14534.*— Same locality. On sand and rock, covering summit, quartzite base. Lat. 0°15′ N, Long. 70°35′ W. January 23–25, 1952, *Schultes & Cabrera 15051.*

Brocchinia hechtioides *Mez* in Fedde Repert. Sp. Nov. 12 (1913) 414.

One of the dominant species on the sandstone top of Cerro Isibukuri, *Brocchinia hechtioides* is characteristic of the quartzitic mountains of the Venezuela-Guiana land-mass. Because of its characteristic place in the ecology of these mountain-tops, it seems advisable to publish the accompanying habit photograph.

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. Summit. November 1951, *Richard Evans Schultes & Isidoro Cabrera 14516.*

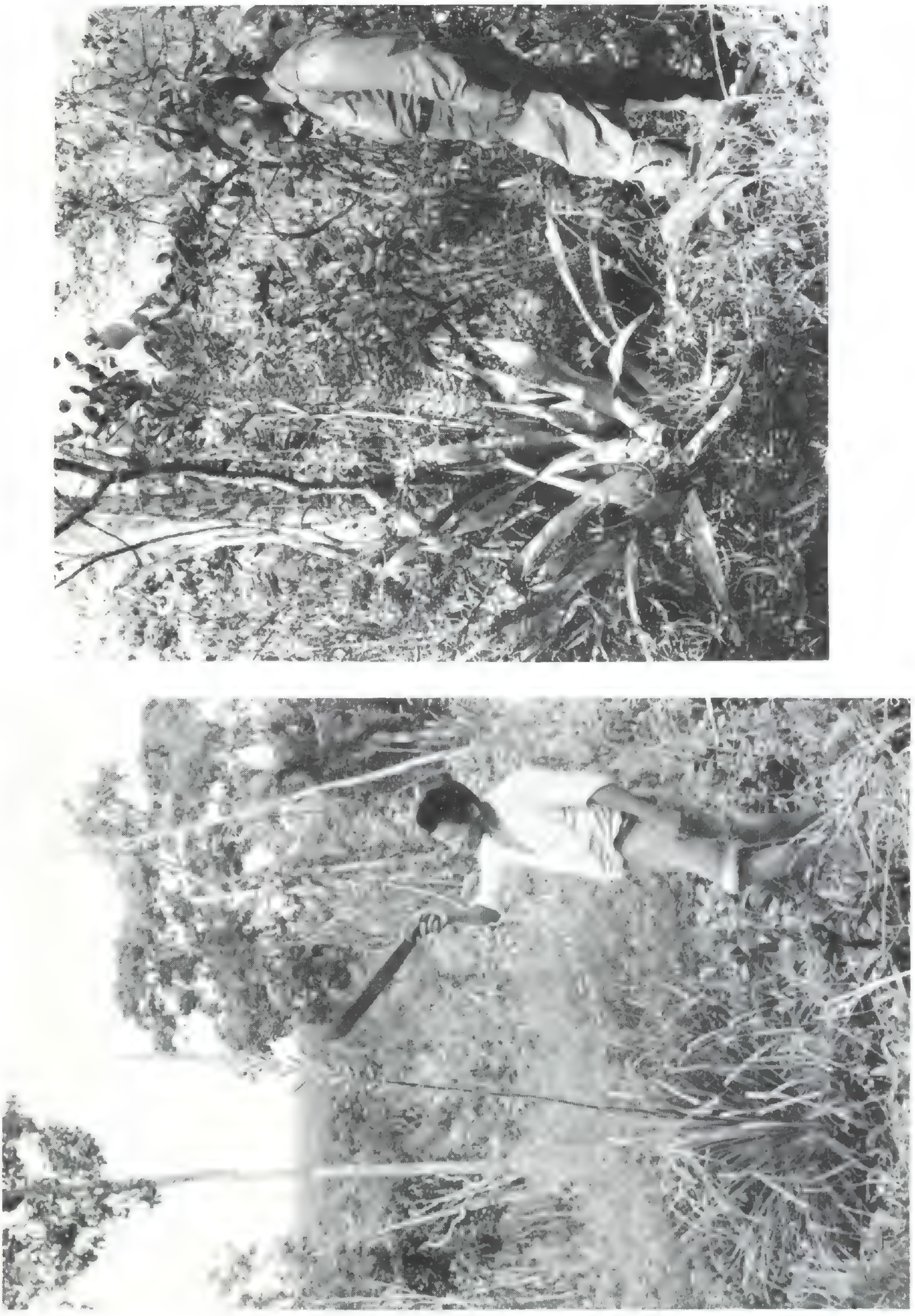
EXPLANATION OF THE ILLUSTRATION

PLATE XIX. (*Left*). PITCAIRNIA TURBINELLA *L. B. Smith.* Habit photograph taken on summit of Cerro Ee-ree-ee-kö-mee-ö-kee, Comisaría del Vaupés, Colombia.

(*Right*) AECHMEA HUEBNERI *Harms.* Habit photograph taken on the lightly wooded slopes of Cerro Ee-ree-ee-kö-mee-ö-kee, Comisaría del Vaupés, Colombia.

Photographs by RICHARD EVANS SCHULTES

Plate XIX



EXPLANATION OF THE ILLUSTRATION

PLATE XX. BROCCHINIA HECHTIOIDES *Mez*. Habit photograph showing the dominance of this species on the flat top of Cerro Isibukuri, Comisaría del Vaupés, Colombia.

Photograph by RICHARD EVANS SCHULTES

Plate XX

Brocchinia serrata *L. B. Smith* in Caldasia [1], no. 4 (1942) 14, f. 2.

For over one hundred years, *Brocchinia* and *Navia* have been separable by a number of supposedly strong characters and, as recently as 1930, Harms (Pflanzenreich 15a: 99, 102) placed them in different subfamilies. With the discovery of *Brocchinia serrata*, however, most of these characters broke down, for, although this species has an appendaged seed and lax inflorescence like those of typical *Brocchinia*, it has also serrate leaves and a largely superior ovary as in *Navia*. There remained an apparent correlation between inflorescence and seed characters, until Maguire brought back some gigantic species of *Navia* (still unpublished) from southern Venezuela.

At the time the distinction of the inflorescence was lost, a better character for separation seemed to be gained in recognizing the cochlear imbrication of the sepals in *Navia*, setting the genus apart from all the *Pitcairnioideae*. However, the discovery of the new and much younger material of *Brocchinia serrata* noted below now demonstrates the same character in *Brocchinia*. This is corroborated in the type species of the genus, *Brocchinia paniculata* Schult.f., by *H. García-Barriga 13731* from the Comisarías Amazonas-Vaupés, Río Apaporis, Jirijirimo. *Brocchinia* and *Navia* thus appear to be more closely related to each other than to any other genera in the *Pitcairnioideae* and, in the final analysis, differ only in the presence or absence of a seed appendage.

COLOMBIA: Comisaría del Vaupés, Río Kuduyarí, Cerro Yapobodá. Alt. 450 m. October 5, 1951, *Richard Evans Schultes & Isidoro Cabrera 14210*.—Same locality. Alt. 270–300 m. Lat. 1°20′ N, Long. 70°30′ W. April 1953, *Schultes & Cabrera 20051*.—Río Kubiyú, Cerro de Kañendá. Alt. 380–680 m. November 2–4, 1952, *H. García-Barriga 15096*.

Vriesia chrysostachys *E. Morren* var. **stenophylla** *L. B. Smith var. nov.*

A var. *chrysostachide* laminis foliorum valde angustioribus acuminatis, petalis albis differt.

Leaf-blades only about 1 cm. wide, acuminate: petals white.

Colombia: Comisarías del Amazonas-Vaupés, Río Apaporis, Cachivera de Jirijirimo y alrededores. Alt. ca. 250 m. "Flowers white, bracts and axis waxy, yellow. On rock ledge in shade of light forest." September 16, 1951, *Richard Evans Schultes & Isidoro Cabrera 14097* (Type in U.S. Nat. Herb. No. 2087659).—Río Apaporis, Raudal de Jirijirimo (below mouth of Río Kananarí). Quartzite base. Alt. ca. 270 m. Lat. 0°5′ N, Long. 70°40′ W. November 11, 1951, *Schultes & Cabrera 14596*.—Same locality. "On cliff," January 21, 1952, *Schultes & Cabrera 14936*.

Vriesia Splitgerberi (*Mez*) *L. B. Smith & Pittendrigh* in Journ. Washington Acad. Sci. 43 (1953) 403.

Guzmania Splitgerberi Mez in DC. Monogr. 9 (1896) 930.

Thecophyllum Splitgerberi (Mez) Pittendrigh in Evolut. 2 (1948) 60.

The specimens cited below constitute the first record for Colombia of a species already known from Surinam, British Guiana, Trinidad, Venezuela, and Costa Rica. For nearly fifty years this species was considered a *Guzmania* confined to the Guianas. Then Pittendrigh discovered flowering material in Trinidad and found that the appendaged petals required its transfer to *Vriesia*. Since then further discoveries have greatly extended its known range.

Colombia: Comisarías del Amazonas-Vaupés, Río Apaporis: entre el Río Pacoa y el Río Kananarí. Soratama. Alt. ca. 250 m. Epiphyte. Bracts greenish at tips, whitish near base. Flowers white. Inflorescence 1 m. long. Leaves tan at base inside and out. June 21, 1951, *Richard Evans Schultes & Isidoro Cabrera 12757*.—Same locality. August 31, 1951, *Schultes & Cabrera 13804*.

Vriesia vexillata *L. B. Smith sp. nov.*

A *Vriesia unilaterali* (Baker) Mez, foliis acutioribus,

scapo elongato gracillimo, scapi bracteis fulgide purpureis, bracteis florigeris secundis tenuioribus differt.

Known only from fragments, but almost certainly stemless, 85 cm. high; leaves to 53 cm. long, obscurely punctulate-lepidote, sheaths broadly elliptic, 7 cm. long, pale, blades ligulate, acuminate, 25 mm. wide, flat, purple toward the base; scape straight, very slender; scape-bracts strict, closely enfolding the scape, lanceolate, characeous, glabrous, purple when dry; inflorescence simple, the single incomplete specimen laxly 4-flowered but probably not much larger, glabrous; floral bracts secund with the flowers broadly elliptic, apiculate, to 35 mm. long, less than twice as long as the internodes, thin, nerved, ecarinate; pedicels slender, 5 mm. long; sepals elliptic, obtuse, 25 mm. long, exserted, thin, nerved, castaneous; petals slightly exceeding the sepals, pale yellow when dry; stamens included; capsule slenderly ellipsoid, slightly exceeding the sepals, long-beaked.

COLOMBIA: Comisaría del Vaupés, Río Papurí, Teresita. "Epiphytic. Caatinga forest." May 27, 1953, *Richard Evans Schultes & Isidoro Cabrera 19443* (TYPE in U.S. Nat. Herb. No. 2087661).

Araeococcus flagellifolius *Harms* in Notizbl. 10 (1929) 784.

The collection noted below constitutes the first record of the genus *Araeococcus* for Colombia. The species was described originally from the state of Amazonas, Brazil, and has been found since in Venezuela.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs about 15 miles upstream from mouth. Quartzite base. Alt. 240–270 m. Lat. 1°0′ N, Long. 70°15′ W. November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18348*.

Streptocalyx subnuda *L. B. Smith sp. nov.*

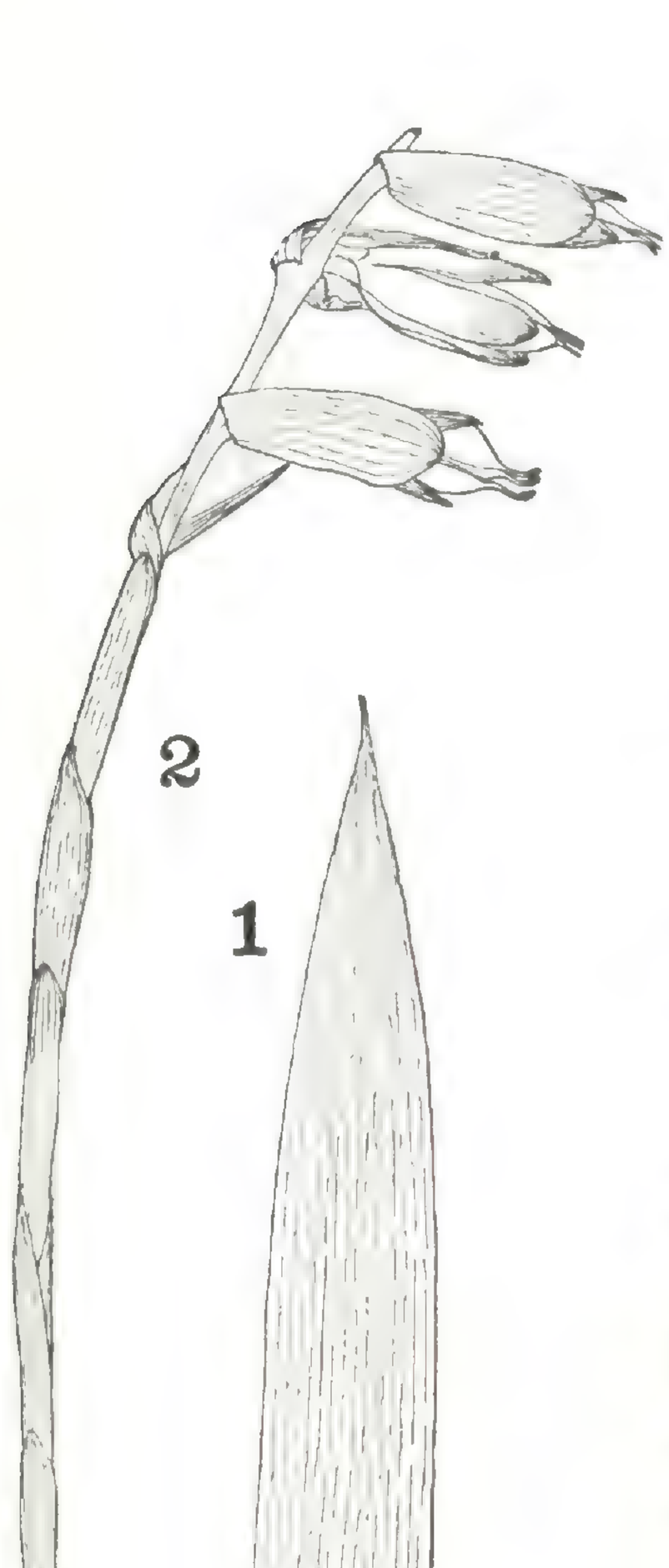
A S. Poeppigii Beer, cui affinis, bracteis primariis superioribus valde reductis quam eis florigeris vix majoribus differt.

EXPLANATION OF THE ILLUSTRATION

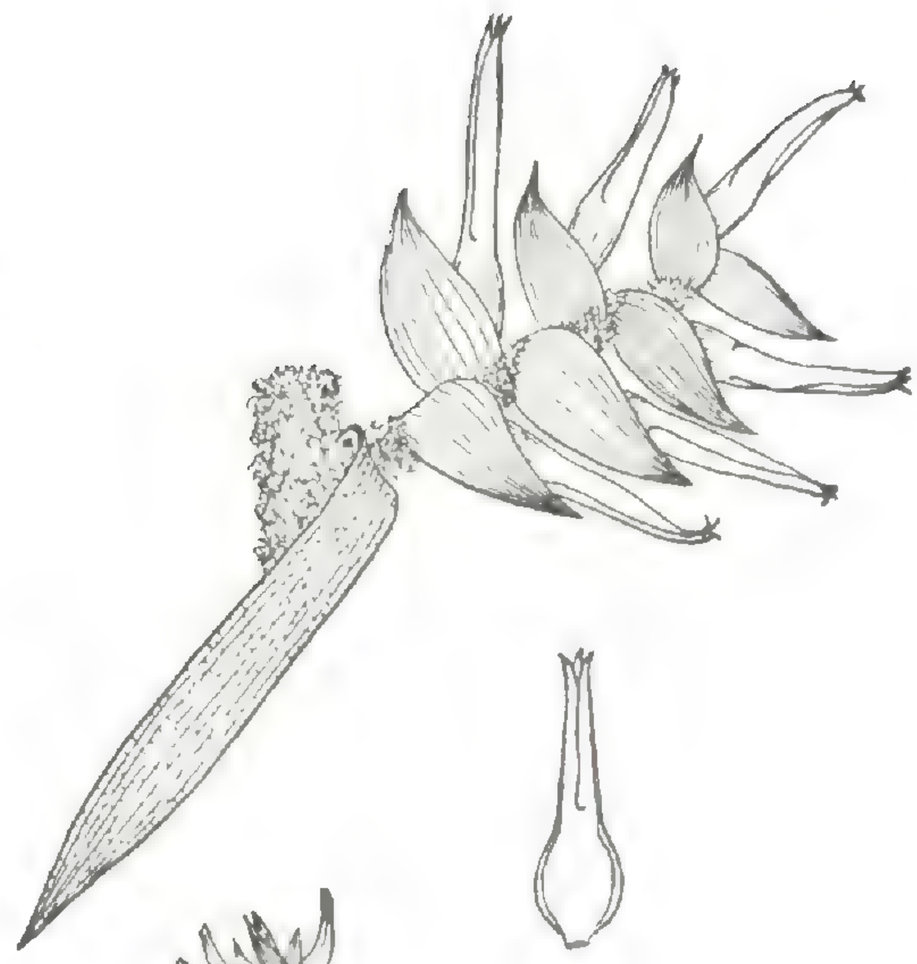
PLATE XXI. VRIESIA VEXILLATA *L. B. Smith.* 1, leaf-blade, one half natural size. 2, upper scape and inflorescence, one half natural size.

AECHMEA STENOSEPALA *L. B. Smith.* 3, leaf blade, one half natural size. 4, upper scape and inflorescence, one half natural size. 5, spike, natural size. 6, flower, natural size. 7, sepal, natural size. 8, section of ovary, twice natural size.

Plate XXI


2

1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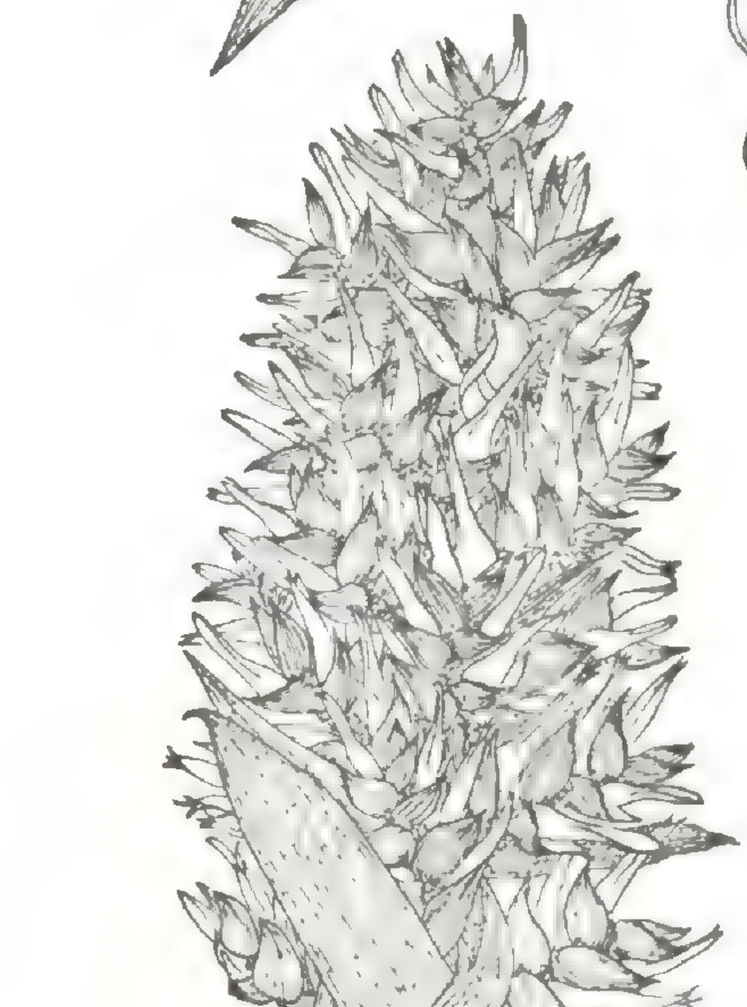
7

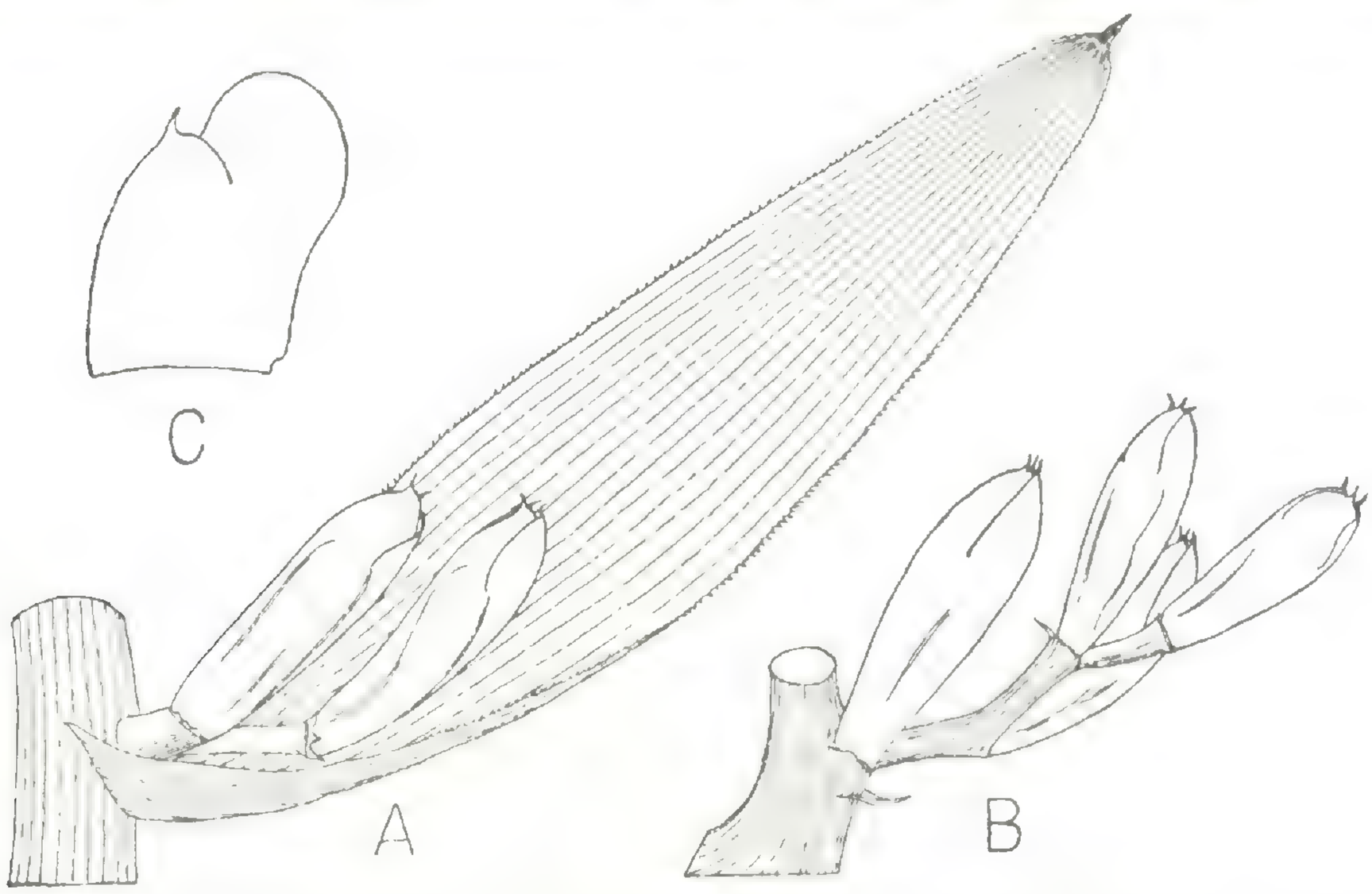
8



3

4

Known from fragments only but obviously 1 m. or more high, coarse; leaves about 1 m. long, the blades ligulate, acuminate, thickened at apex, 7 cm. wide, covered with white appressed scales, laxly serrulate; scape stout, densely farinose-lepidote; scape-bracts elliptic, 15 cm. long, the upper densely imbricate, serrulate, subchartaceous, rose, subulate-indurate at apex; inflorescence bipinnate, cylindric, 26 cm. long, farinose-lepidote,



A, basal primary bract and branch, natural size. B, apical primary bract and branch, natural size. C, sepal, twice natural size.

the lowest primary bracts like the scape-bracts, exceeding the branches, the others abruptly reduced and little if at all larger than the floral bracts; branches spreading, 6 mm. long, geniculate, laxly few-flowered; floral bracts vestigial, narrowly reniform with an acicular apex; flowers divergent; sepals asymmetric with a large wing, mucronate, 11 mm. long; petals and stamens unknown; ovary slenderly obovoid or ellipsoid, becoming 15 mm. long in fruit, epigynous tube broadly funnel-form, 2 mm. high, placentae apical.

COLOMBIA: Comisaría de Putumayo, Río Caucaya, entre Puerto Jaramillo y el Río Putumayo, alt. 225 m. "Epiphytic." May 16, 1942, *Richard Evans Schultes 3719* (TYPE in Herb. Gray).

Aechmea Huebneri *Harms* in Notizbl. 10 (1929) 581.

Described from Manáos in Amazonian Brazil, *Aechmea Huebneri* has hitherto not been reported from Colombia. Here, it is a large plant of the lightly shaded slopes, as shown by the accompanying habit photograph, but it apparently does not occur on the sun-flooded tops of these sandstone mountains.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná, Raudal Mö-kö, Cerro Ee-ree-ee-kö-mee-ö-kee. "Terrestrial. Inflorescence axis and bracts scarlet. Flowers purple. Leaves inside deep purple-brown at base, full of fierce ants. Small leaves purple within nearly whole length." September 18, 1952, *Richard Evans Schultes & Isidoro Cabrera 17494.*

Aechmea stenosepala *L. B. Smith sp. nov.*

A *Aechmea pubescenti* Baker, cui affinis, inflorescentia dense bipinnata, sepalis magnis, anguste oblongis differt.

Over 6 dm. high: leaves presumably rosulate and forming an ellipsoid tank, to 52 cm. long, covered with closely appressed scales, sheaths broadly elliptic, castaneous, those of the outer leaves 17 cm. long, those of the inner 25 cm. long, blades of the outer leaves ligulate, broadly acute and recurved near the apex, 8 cm. wide, cinereous-lepidote, laxly serrate with dark ascending flat teeth 6 mm. long, blades of the inner leaves vestigial; scape erect, 5 mm. in diameter, white-lanate; scape-bracts lanceolate, acute, about equaling the internodes, membranaceous, rose-purple, densely pale-lepidote, laxly and obscurely serrulate; inflorescence bipinnate, densely ellipsoid, 12 cm. long; lowest primary bracts like the scape-bracts, the others greatly reduced; spikes divergent, densely few-flowered; rhachis angled but not alate or excavated, densely pale-lanate; floral bracts distichous, much more than twice as long as the internodes but spreading and not imbricate, broadly ovate, acuminate,

mucronate, 7 mm. long, nerved; sepals asymmetric, narrowly oblong, subtruncate, mucronate, 10 mm. long, connate for 1 mm.; petals imperfectly known; ovary globose, placentae apical.

COLOMBIA: Comisaría del Vaupés, Mesa La Lindosa. Small range 15–20 km. south of San José del Guaviare. Alt. 400–600 m. December 13–15, 1950, *Jesús M. Idrobo & Richard Evans Schultes 645* (TYPE in U.S. Nat. Herb. No. 2025998).

Navia heliophila *L. B. Smith ex Schultes* in Bot. Mus. Leafl. Harvard Univ. 16 (1954) 194, t. 26, figs. 5–8, t. 27.

These additional collections of *Navia heliophila* indicate that it is a rather frequent species on the cliffs of the middle course of the Río Apaporis.

COLOMBIA: Comisaría del Amazonas-Vaupés, Río Apaporis, Raudal de Jirijirimo y alrededores. Alt. ca. 250 m. "On rocks on face of ledge. Flowers white; anthers yellow." June 13, 1951, *Richard Evans Schultes & Isidoro Cabrera 12457*.—Same locality. "On rocky ledge in sun. Flowers white; anthers yellow. Leaves glossy." September 16, 1951, *Schultes & Cabrera 14050*.—Comisarías del Amazonas-Vaupés, Río Apaporis, Raudal Yayacopi (La Playa) and vicinity. Quartzite base. Alt. about 800 feet. General location: Lat. 0°5′ S, Long. 70°30′ W. "On cliffs. Flowers white; anthers yellow." February 15, 1952, *Schultes & Cabrera 15380*.

PONTEDERIACEAE

Pontederia cordata *Linnaeus* Sp. Pl. (1753) 288.

Pontederia cordata, rare in the headwaters of small rills and creeks which flow into the main rivers of the Comisaría del Vaupés, seems never to have been reported from Amazonian Colombia.

COLOMBIA: Comisaría del Vaupés, Río Paca (tributary of Río Papurí). Alt. about 650 feet. General location: Lat. 0°30′ N, Long. 70°10′ W. "In headwaters of Río Paca. Flowers white. In water." June 1–3, 1953, *Richard Evans Schultes & Isidoro Cabrera 19526*.

VELLOZIACEAE

Vellozia Dumitiana *R. E. Schultes* in Mutisia 12 (1952) 2, t. 6, 7.

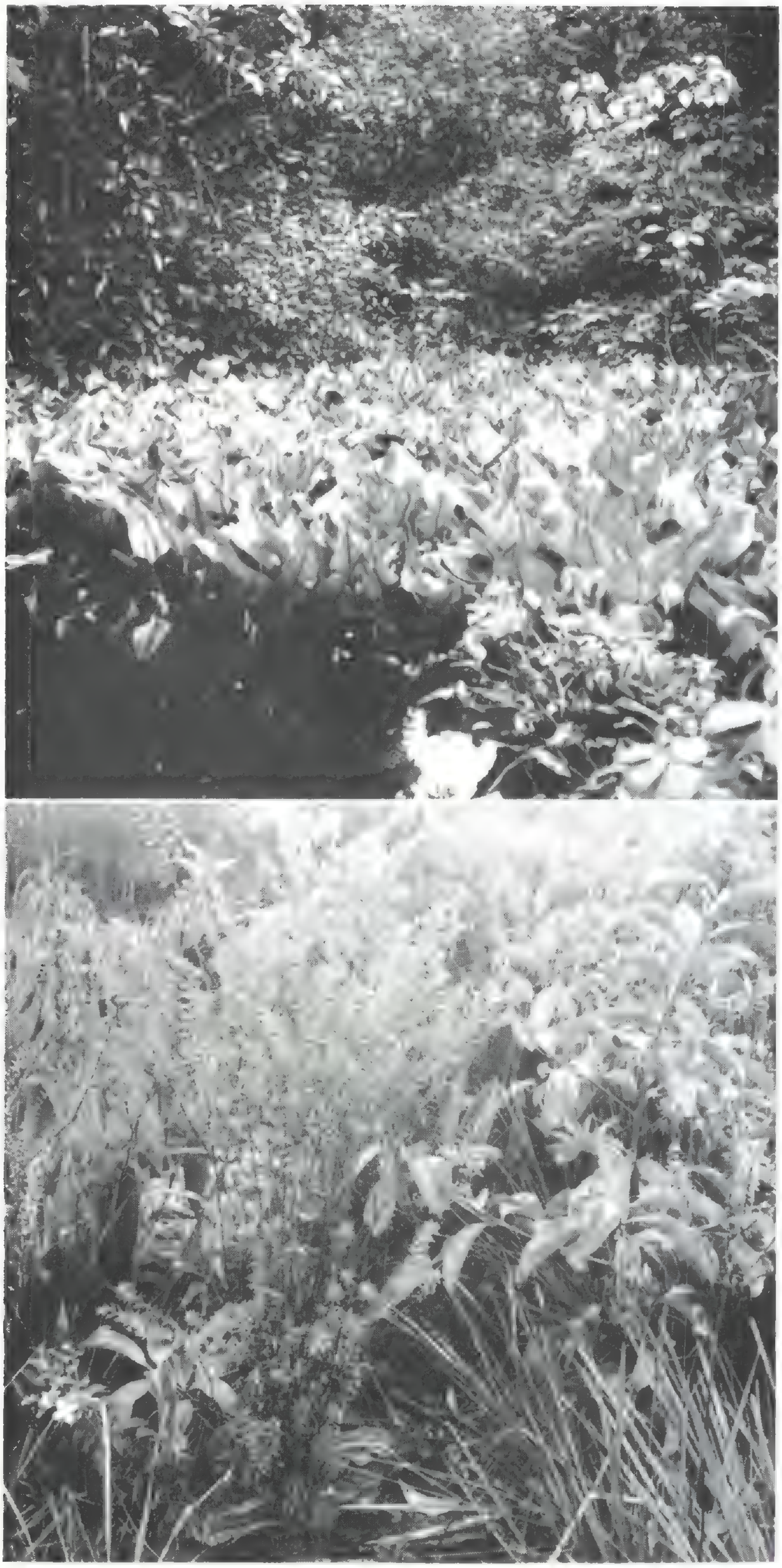
EXPLANATION OF THE ILLUSTRATION

PLATE XXII. (*Upper*) PONTEDERIA CORDATA L. Habit photograph of *Pontederia cordata* in the headwaters of the Río Pacoa, Comisaría del Vaupés, Colombia.

(*Lower*) LEITGEBIA COLOMBIANA *R. E. Schultes.* Habit photograph of *Leitgebia colombiana* (the shrub with the fine leaves) at Yapobodá, Río Kuduyarí, Comisaría del Vaupés, Colombia.

Photographs by RICHARD EVANS SCHULTES

Plate XXII



This topotypical material of *Vellozia Dumitiana* represents the fifth collection of this curious shrub, all from Cerro Isibukuri, where the species appears to be a very restricted endemic.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. General location: Lat. 0°15′ N, Long. 70°35′ W. Quartzite base. At summit of mountain. January 23–25, 1952, *Richard Evans Schultes & Isidoro Cabrera 15050A*.

Vellozia lithophila *R. E. Schultes* in Rev. Acad. Col. Ciénc. Exact., Físico-Quím. Nat. 8, no. 32 (1952) 459.

Reported hitherto from savannahs at San José del Guaviare and Yapobodá, *Vellozia lithophila*, through the first two collections cited below, is now known to be more widely distributed in the Colombian Vaupés.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs about 15 miles upstream from mouth. Quartzite base. Alt. about 800–900 feet. "Very common on savannah. Height up to 6 feet." November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18317*.—Comisaría del Vaupés, Río Paraná Pichuna (tributary of Río Vaupés). Alt. about 700 feet. General location: Lat. 1°10′ N, Long. 70°30′ W. June 1953, *Schultes & Cabrera 19945*.—Comisaría del Vaupés, Río Kuduyarí (tributary of Río Vaupés), Yapobodá. Quartzite savannah near headwaters. Alt. about 900–1000 feet. General location: Lat. 1°20′ N, Long. 70°30′ W. "Gnarled shrub 6 feet tall, branched." April 1953, *Schultes & Cabrera 20019*.

MYRISTICACEAE

Virola calophylla *Warburg* in Nova Acta Acad. Leop.-Carol. 68 (1897) 231.

This species is known from Amazonian Brazil and adjacent parts of Colombia, Perú and Venezuela. Prior to the collection of the material cited below, the species was recorded from Colombia only from the region of Villavicencio in the Orinoco drainage-area. It is, however, quite common in the Colombian Amazonia.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama, entre el Río Pacoa y el Río Kananarí. Alt. about 250 m. June 26, 1951,

Richard Evans Schultes & Isidoro Cabrera 12855.—Same locality, August 16, 1951, *Schultes & Cabrera 13587.*—Same locality, December 1952, *Hernando García-Barriga 13859.*—Same locality and date, *García-Barriga 14059.*

Virola calophylloidea *Markgraf* in Repert. Sp. Nov. 19 (1923) 24.

Virola calophylloidea, the type of which was collected in Manáos by Ule (*Ule 8846*) half a century ago, is rare in Amazonian Brazil in the Rio Negro and Rio Madeira valleys. Hitherto, it has not been known from Colombia, where it appears to be much rarer than *Virola calophylla* in the Amazonian forests.

Colombia: Comisaría del Amazonas, Río Apaporis, Soratama, entre el Río Pacoa y el Río Kananarí. Alt. about 250 m. July 3, 1951, *Richard Evans Schultes & Isidoro Cabrera 12872.*—Same locality. December 1952, *Hernando García-Barriga 13964.*—Same locality and date, *García-Barriga 13986.*

Leguminosae

Hymenaea oblongifolia *Huber* in Bol. Mus. Para. 5 (1909) 386.

The collection cited below increases our knowledge of the distribution of *Hymenaea oblongifolia* in the Colombian Amazon, the westernmost extent of its range. It has hitherto been collected in La Pedrera on the Río Caquetá, in the upper Apaporis basin and in the Cordillera La Macarena (Schultes in Bot. Mus. Leafl. Harvard Univ. 16 (1953) 68).

Colombia: Comisaría del Amazonas, Río Miritiparaná, Caño Guacayá. Alt. about 700 feet. General location: Lat. 0°30′ S, Long. 70°40′ W. "Tall tree, 70 feet. Fruit reddish brown. Leaves glossy, Common name=*jutaí.*" April 24, 1952, *Richard Evans Schultes & Isidoro Cabrera 16257.*

Euphorbiaceae

Conceveibastrum Martianum (*Baill.*) *Pax & Hoffman* in Pflanzenr. 4, Heft 147, 7 (1914) 217.

Known from the Rios Solimões and Japurá in Brazil, *Concevcibastrum Martianum* appears to be new for the flora of Colombia.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri, near summit. General location: Lat. 0°15′ N, Long. 70°35′ W. January 23–25, 1952, *Richard Evans Schultes & Isidoro Cabrera 15036*.

ICACINACEAE

Poraqueiba sericea *Tulasne* in Ann. Sci. Nat., sér. 3, 11 (1849) 172.

This curious cultivated fruit-tree of the western Amazonas is in need of further field investigation. There are several distinct "varieties" which differ primarily in the color of the ripened fruit. In the Colombian Vaupés, where the tree and its fruit are known as *umarí*, there are four: *umarí amarillo*, *umarí blanco*, *umarí colorado* and *umarí verde*. *Schultes & Cabrera 17319* represents *umarí amarillo*, the most abundant of these varieties.

We may report the following Indian names for *Poraqueiba sericea* in Amazonian Colombia: Puinave=*how;* Barasana=*wa-mö′*.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná (tributary of Río Apaporis), Caño Teemeeña. General location: between Lat. 0°15′ S, Long. 70°30′ W and Lat. 0°25′ N, Long. 70°30′ W. "Small tree. Cultivated. Flowers yellow." September 9, 1952, *Richard Evans Schultes & Isidoro Cabrera 17319*.

SAPINDACEAE

Cardiospermum Halicacabum *Linnaeus* Sp. Pl. (1753) 366.

Without exception, the adult males amongst the Indians of the Makuna, Barasana, Taiwano and other tribes of the Piraparaná and middle and lower Apaporis basins wear, above the biceps, curious arm bands made from the small seeds of *Cardiospermum Halicacabum*. This plant is cultivated around the edges of the plots of *Manihot* to

assure a supply of these seeds solely for making arm bands. It has apparently never been reported as a cultivated plant.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná (tributary of Río Apaporis), Raudal Guá-kõ-nõ-ta. General location: between Lat. 0°15′ S, Long. 70°30′ W and Lat. 0°25′ N, Long. 70°30′ W. "Small vine on ground. Cultivated. Black seeds used for arm bracelets. Flowers white. Living seed dark bluish. Puinave = *ñé-yot;* Makuna = *bö-rá.*" September 4, 1952, *Richard Evans Schultes & Isidoro Cabrera 17170.*

BOMBACACEAE

Bombax coriaceum *Martius & Zuccarini* Nov. Gen. & Sp. 1 (1824) 93 in obs.; K. Schumann in Martius Fl. Bras. 12, pt. 3 (1886) 219.

The collections cited below provide additional evidence that *Bombax coriaceum*, though never abundant, is one of the widespread endemics on the Cretaceous quartzitic remnant hills of eastern Colombia.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs about 15 miles upstrea m from mouth. Quartzite base. Alt. about 800–900 feet. General location: Lat. 1°0′ N, Long. 70°15′ W. "Height 5 feet. Low bush. Petals externally reddish brown, internally white, anthers white." November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18316.*—Comisaría del Vaupés, Río Paraná Pichuna (tributary of Río Vaupés). Altitude about 700 feet. General location: Lat. 1°10′ N, Long. 70°30′ W. June 1953, *Schultes & Cabrera 19928.*—Comisaría del Vaupés, Río Kuduyarí (tributary of Río Vaupés); Yapobodá. Quartzite savannah near headwaters. Alt. about 900–1000 feet. General location: Lat. 1°20′ N, Long. 70°30′ W. "Low bush." April 1953, *Schultes & Cabrera 20034.*

Matisia apaporiensis *Cuatrecasas sp. nov.*

Frutex, ramis cortice molli pallide ochraceo, hornotinis stellato-tomentellis deinde glabris. Folia simplicia alterna chartacea. Petiolus subtenuis, 1.5–3 cm. longus, ochraceo-tomentellus pilis gracilibus stellatis praeditus, teres, superiore parte incrassatus. Lamina obovato-oblonga vel elliptico-oblonga basi obtuse cuneata, apice subito attenuata cuspidataque, margine integra vel sursum leviter

sinuata, 12–26 cm. longa, 4–8 cm. lata, utrinque in sicco pallide viridis subglabraque, sparsissime pilis stellatis vel simplicibus praecipue supra costam munita; supra laevis, costa subfiliformi eminenti nervis lateralibus parum prominulis reticulo nervorum leviter notata; subtus costa crassiuscula prominenti nervis secundariis 6–8 utroque latere angustis sed prominentibus, basilaribus subrectis ascendentibus ceteribus ascendenti-arcuatis ad marginem decurrenti-anastomosantibus, nervis tertiis transversis tenuibus prominulisque, cum minoribus reticulatis. Flores solitarii vel pares extraaxillares in ramulis hornotinis, pedunculo rigido crassiusculo 1.5–2.5 cm. longo, parte media duobus apice una bracteolis linearibus minutis (1.5–3 mm. longis) deciduis. Calyx crassus, subcoriaceus, tubulosus vel tubuloso-conicus, 2–2.2 cm. longus basi cuneatus, margine 4 lobis inaequalibus circa 5–6 mm. longis rotundatis vel obtusis, intus dense villoso-sericeus, extus item pedunculus ochraceo-subvelutinus, superficie sublaevi basim versus leviter granulosa pilis minutis gracilibus fasciculatis patentibus densissime tectus. Petala 5 alba, crassiuscule membranacea, ovato- vel obovato-oblonga, apice rotundata, basi longe in unguem angustata, circa 3 cm. longa, 1 cm. lata, supra villosa, subtus pilis crassis sparsis munita et pilis stellatis gracilibus densissimis vestita. Staminorum columna crassiuscula, albido-tomentosa pilis sparsis crassis simplicibus et pilis stellato-fasciculatis densis tecta, circa 5.5 cm. longa, parte extrema in quinque lacinias antheriferas lineares crassas, circa 1 cm. longas, extus tomentellas, intus glabras productа; laciniis sex antherarum loculis elliptico-oblongis 3–4 mm. longis instructis, sed loculis inferioribus parte superiore ampliata tubi concrescentibus. Stylus erectus, exsertus, minute tomentoso-hirtellus. Stigma breviter capitatum, glabrum, minute papillosum, 5-lobatum. Ovarium 5-loculare, loculis biovulatis.

Matisia apaporiensis is closely related to *M. putumayensis* Cuatr., but differs from it in its thinner, more cuneate leaves, in its tomentose petioles, in its few stellate hairs scattered on the leaf-blades, in its broader, thinner calyx, in its larger petals and androecium, and in the softer indument of its calyx. In *Matisia putumayensis*, the calyx is ferrugineous, minutely granulate and covered with a shorter and denser velutinous tomentum. Similar characters differentiate the new species from the related *Matisia lasiocalyx*, in which the petioles are more or less pubescent, and the calyx is not granulate on its main surface.

Colombia: Comisaría del Amazonas, Río Ricapuyá (tributary of the Río Apaporis below mouth of Río Piraparaná). Alt. about 700 feet. General location: Lat. 0°25′ S, Long. 70°30′ W. "Bush. Flowers yellow. Makú = *bo-o-tag;* Makuna = *mee-cheé-ge-hai;* Puinave = *dó-kön.*" September 1952, *Richard Evans Schultes & Isidoro Cabrera 17641* (Type in Herb. Gray).

Matisia Idroboi (*Quatrecasas* in Phytol. 4 (1954) 476.

It has been thought advisable to publish the accompanying plate of the type plant of this remarkable species of *Matisia*.

Colombia: Intendencia del Meta, Cordillera La Macarena (extremo nordeste), Macizo Renjifo, cumbre y alrededores. Alt. 1360–1900 m. January 1951, *Jesús M. Idrobo & Richard Evans Schultes 1001*.

Sterculiaceae

Herrania umbratica *R. E. Schultes* in Caldasia 2 (1943) 261, t. p. 263.

In 1943, I described *Herrania umbratica* from a fruiting collection made by Señor Jorge Ortíz Méndez in the Municipio de Girón in the Departamento de Santander, Colombia. Flowers were not available, and, for this reason, the exact relationship of this concept has been doubtful. The gross morphology of the capsule suggested a

relationship with *Herrania nycterodendron* from the Amazon basin of Colombia and Perú, but the leaves of the two species are quite distinct. More recently, I had come to believe that *Herrania umbratica* perhaps might be allied to *H. albiflora*, notwithstanding the significant differences in the structure of the capsule. Inasmuch as *Herrania albiflora* is one of those species of *Herrania* with a patelliform calyx (with sepals that are connate for only half their length and which, therefore, do not fully open in anthesis) and *H. nycterodendron* has, like most of the species, a subcymbiform calyx (with sepals separated to their base and which, therefore, open widely), the assignment of *H. umbratica* to its proper relationship was greatly to be desired.

In January 1953, Mr. Douglas Taylor, entomologist on the Anglo-Colombian Cacao Collecting Expedition, made a collection of the only species of *Herrania* found under cultivation in the Granja Experimental at Palmira, Colombia. Mr. Taylor submitted the collection to me for examination. It consisted of leaves, one flower and one under-ripe fruit from one of the seven trees at Palmira. A week later, I visited Palmira and was able to examine the trees in greater detail and to make another flowering collection. All seven individuals represent the same species. There are no records at Palmira stating who introduced the material and from what region.

A detailed examination of the fruit of Taylor's collection and a study of the living plants (growing in an unshaded field) leave no doubt that the species is *Herrania umbratica*. There is no other known species with which the fruit could be confounded, and the leaves, albeit somewhat smaller than those of the shade-growing type of *Herrania umbratica*, are identical in shape, texture and indumentum.

The capsule of Taylor's collection was elongate-

ellipsoidal, very irregular and with a blunt, rounded apex which is not strongly constricted as in *Herrania albiflora* and as, indeed, in most species of the genus. Basally, it is obtusely rounded and not indented, and is attached by a strong, woody peduncle 15 mm. long and 4 mm. in diameter. The ribs are subequal and are thickly carnose and bluntly rounded; both the primary and secondary ribs are armed along the sides with strong stinging hairs. Between the ribs, the fleshy-coriaceous pericarp is somewhat striate-fibrose. The capsule measured (in the fresh state) 12 cm. in length and 4 cm. in diameter at its widest part. It had twenty-two seeds, whereas the fruit of the type had forty-two.

The fortunate chance that Taylor was able to find one mature flower on the same tree from which the fruit was taken makes it possible to complete the description of *Herrania umbratica* and to establish its relationship with those species possessing a patelliform calyx, and more especially with *H. albiflora*.

Herraniae umbraticae inflorescentiae fasciculatae, multiflorae. Flores caulinares ex trunco inferiore in racemis contractis prorumpentes, breviter pedicellati; reserati globosi, 18–22 mm. in diametro. Pedicelli usque ad 5 mm. longi, dense fulvo-tomentosi, articulati basi brevi cum bractea lineari minuta subtenti. Alabaster globosus plerumque 10–12 mm. in diametro. Calyx patelliformis, in partes duo obscure divisus. Sepala crassissima, duo, pro longitudine maxima connata, subaequalia, rotundato-ovata, integra, apice rotundata, plusminusve 22 mm. longa, 22 mm. lata, intus glabra, subpurpurea, extus fulva, densissime minutissime stellato-pilosa atque sparse grossiuscule stellato-pilosa. Petala quinque, sessilia, crassa, sanguinea, concava, obovata, plerumque 9 mm. longa, 8 mm. lata, apice valde cucullata, intus quinque cum nervis crasso-callosis purpureis muricato-

papillosis, inter nervos glaberrima sed propter marginem crassam dense muricato-papillosa; ligulae lineares, 19 mm. longae, parte inferiore 2 mm. latae, basi valde et abrupte contractae, in alabastro spiraliter intortae sed in anthesi erectae, ochrorubrae, minute granulosae. Tubus stamineus quinque-divisus, staminibus invicem duo- et quattuor-antheriferis, filamentis valde complanatis, brevibus liberisque, antheris bilocularibus, loculis 1.5 mm. longis, 0.6 mm. latis, flavis. Staminodia crassa, conspicue petaloidea, sublutea, valde deflexa, petala antherasque celantia, oblanceolato-elliptica, integra, apice subacuta, 20 mm. longa, 10 mm. lata, utrinque dense papilloso-granulosa. Ovarium sessile, elongato-ovoideum, distincte decemcostatum atque quinqueloculare, rufo-aureum, densissime stellato-pilosum, 3 mm. in diametro. Stylus crasso-teres, simplex, flavus, in stigmata apice conspicue quinquedivisus, 1 mm. longus.

The stipules of *Herrania umbratica* have not been known, for the type collection was devoid of these structures. The collector, however, made an annotation of their size. In the original description, I wrote: "Stipulae non visae, sed (ex collectore) membranaceae, 3–6 cm. longae describuntur." A study of the stipules on the plants growing at Palmira indicates that these structures are indeed enormous. We might describe them as follows: Stipulae chartaceae, fuscae, densissime tomentellae, lineares, 30–60 (plerumque 55–60) mm. longae, 2.5–4 mm. latae.

In February 1953, whilst on a visit to the Imperial College of Tropical Agriculture in Trinidad, I found one tree referable to *Herrania umbratica* in cultivation in the experimental gardens. There is apparently no record of the place of origin of this tree. It was identified as *Herrania umbratica* through several very young capsules which, despite their immaturity, showed all the charac-

teristics of the fruit of this species. Subsequently, the late Professor Richard E. D. Baker of this institution informed me by letter (March 12, 1953) that the tree was in flower, stating: "The buds are spherical, the pedicels very short, 2–3 mm. only; the calyx splits into three and does not open much; the staminodes are thick and fleshy, and the ligules are very short, only about 1 cm. long; the staminodes are dark, and the ligules pale crimson." All of these curious characters agree perfectly with those of the collection which has been chosen as the type of the description of the flowers of *Herrania umbratica*. A flowering specimen from this tree (*R. E. D. Baker sine num.*) does indeed show these characters so peculiar to *Herrania umbratica*.

On February 2, 1953, Dr. Francis W. Cope of the Anglo-Colombian Cacao Collecting Expedition visited Capitancitos and examined the original tree from which the type material of *Herrania umbratica* had been taken. I take the liberty of transcribing here Dr. Cope's very full notes made on the living plant:

Small tree, about 6 metres high, branched into two equal branches at about 3 metres from the ground. About 10 cm. at base in diameter. Leaves large, predominantly 5-foliate, with very long petiole, averaging 48 cm. (39–54 cm. range). Petiole approximately cylindrical with numerous faint grooves, 8 mm. at base, tapering to 6 mm. at apex. Base of petiole swollen. Covered with dense, rusty-coloured stellate hairs. Stipules 3.5 cm. long, membranaceous, tapering, darkly stellate-pilose. Leaflets unequal in size, sessile, papery in texture, long-ovate, somewhat unequal, with entire margins, tapering into acuminate tip about 3 cm. in length. Upper surface dark shining green, with dark rusty hairs on midrib and first order veins; smaller nerves with very distant stellate hairs. Lower surface a paler green, with very prominent midrib and first order veins, which are densely covered with pale stellate hairs. Lamina with numerous single stellate hairs inserted on veinlets. Central leaflet up to 70 cm. long by 27 cm. broad.

Flower: Sepals 3, joined to middle (also apparent on young fruits) covered with soft stellate hairs, with larger scattered stellate hairs. Other parts not examined, but ligule apparently short.

Fruit: Elongate elliptic, dark shining green when immature, bright

yellow at maturity, 13.5 cm. long×4.5 cm. in diameter, with 10 very blunt and rounded ribs, five rather more prominent than the others, with which they alternate. Larger ribs project about 10 mm. and have a width of 8 mm. at base. Small lateral or transverse ribs. All ribs carry large, scattered stellate hairs of white, shining colour. Pericarp has a thin, woody layer, elsewhere rather soft. Peduncle short (up to 10 mm. in length×4 mm. in diameter, articulated at middle).

It was my very good fortune to be able to see the Palmira trees in July 1953, when they were in extraordinarily profuse flower. One tree had more than 660 flowers and buds in about thirty many-flowered inflorescences scattered along the lower four feet of the trunk but concentrated near the base. The cacao agronomists at the Experiment Station inform me that the trees fruit heavily.

COLOMBIA: Departamento de El Valle, Palmira, Granja Experimental. Cultivated. January 1953, *Douglas Taylor sine num.*—Departamento del Norte de Santander, Río Tibú, above Betrania. "In forest. Flowers not seen." September 8, 1953, *Anglo-Colombian Cacao Collecting Expedition* (*B. G. Bartley & P. Holliday*) *179.*—Departamento del Norte de Santander, Río Oru. "On river bank in forest, commonly inundated up to 18 inches. Fruits 7.6–8×4.1–4.5 cm. Flowers not seen." September 8, 1953, *Anglo-Colombian Cacao Collecting Expedition* (*B. G. Bartley & P. Holliday*) *180.*—Departamento del Norte de Santander, Río Nuevo. "Tree 6–7 m. on river bank in forest. Fruit 8–9.2×4–4.5 cm. Flowers not seen." September 9, 1953, *Anglo-Colombian Cacao Collecting Expedition* (*B. G. Bartley & P. Holliday*) *182.*

TRINIDAD: Imperial College of Tropical Agriculture. Cultivated. "Flowers only partially opening. Ligules pale crimson, short, 1 cm. Pedicel short, 2–3 mm. Pods covered with white stellate hairs." March 10, 1953, *R. E. D. Baker sine num.*

OCHNACEAE

Leitgebia colombiana *R. E. Schultes* in Bot. Mus. Leafl. Harvard Univ. 16 (1953) 85.

Recently described from Mount Chiribiquete in Amazonian Colombia, *Leitgebia colombiana* represents the third known species of this genus, which is apparently

EXPLANATION OF THE ILLUSTRATION

PLATE XXIII. (*Upper*) MATISIA IDROBOI *Cuatrecasas*. A branch from the type of *Matisia Idroboi*.

(*Lower*) BOMBAX CORIACEUM *Martius & Zucc.* Flowering branch of the shrub from which *Schultes & Cabrera 18316* was taken.

Photographs by RICHARD EVANS SCHULTES

N.B. The upper and lower captions, as printed, should be reversed.

Plate XXIII

EXPLANATION OF THE ILLUSTRATION

PLATE XXIV. (*Left*) HERRANIA UMBRATICA *R. E. Schultes*. Base of flowering tree cultivated at the Granja Experimental in Palmira, Colombia.

(*Right*) Fruit from the collection *Taylor sine num.*, Palmira, Colombia.

Photographs by RICHARD EVANS SCHULTES

Plate XXIV

endemic to the ancient Venezuela-Guiana land-mass to which the isolated quartzitic hills of eastern Colombia belong. The discovery of this species in three additional localities in the Comisaría del Vaupés, always in association with the curious flora characteristic of these hills, indicates that it is indeed distributed over a wide area. In each of the localities for which it is now known, it is an extremely abundant element of the savannah vegetation.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs about 15 miles upstream from mouth. Quartzite base. Alt. about 800–900 feet. General location: Lat. 1°0′ N, Long. 70°15′ W. November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18375.*—Comisaría del Vaupés, Río Paraná Pichuna (tributary of Río Vaupés). Alt. about 700 feet. General location: Lat. 1°10′ N, Long. 70°30′ W. June 1953, *Schultes & Cabrera 19952.*—Comisaría del Vaupés, Río Kuduyarí (tributary of Río Vaupés). Yapobodá. Quartzite savannah near headwaters. Alt. about 900–1000 feet. General location: Lat. 1°20′ N, Long. 70°30′ W. "Bush 8 feet tall." April 1953, *Schultes & Cabrera 19984.*

FLACOURTIACEAE

Euceraea nitida *Martius* Nov. Gen. & Sp. 3 (1829) 90, t. 238.

Euceraea nitida was described from the Rio Japurá of Brazil, but the type may have been collected in the territory now included in Colombia, probably in the region of the Cerro de La Pedrera. Its occurrence is widespread though very disrupted. A rare species in our herbaria, it appears to be associated with the remnant floras of the Venezuela-Guiana land-mass, ranging from an easternmost station in Dutch Guiana (Tafelberg: *Maguire 24396a*) to its westernmost one on Cerro Isibukuri in Colombia.

COLOMBIA: Comisaría del Vaupés, Río Kananarí (affluent of Río Apaporis), Cerro Isibukuri, near summit. January 23–25, 1952, *Richard Evans Schultes & Isidoro Cabrera 15035.*—Same locality and date. *Schultes & Cabrera 15039.*

Lythraceae

Cuphea kubeorum *Lourteig ex Schultes* in Bot. Mus. Leafl. Harvard Univ. 16 (1954) 221, t. 35.

Schultes & Cabrera 18359 is a topotypical collection and *19177* is from the same general area as the type. The concept appears to be a rather restricted endemic.

Colombia: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá, savannahs about 15 miles upstream from mouth. Quartzite base. Alt. about 800–900 feet. General location: Lat. 1°0′ N, Long. 70°15′ W. "Flowers pink." November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18359.*—Same locality and date. "Flowers pale mauve." *Schultes & Cabrera 18396.*—Comisaría del Vaupés, Río Karurú (tributary of Río Vaupés), Mesa de Yambí, savannah Goo-ran-hoo-da. Quartzite base. Alt. about 950–1000 feet. General location: Lat. 1°20′ N, Long. 71°20′ W. "Flowers purple." April 15–16, 1953, *Schultes & Cabrera 19177.*

Melastomaceae

Graffenrieda fantastica *R. E. Schultes & L. B. Smith* in Bot. Mus. Leafl. Harvard Univ. 13 (1949) 306, t. 35.

This is the second collection of *Graffenrieda fantastica* from Colombia. The type locality is Cerro Chiribiquete, more than 120 miles to the northwest of Cerro Isibukuri.

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. August 4, 1951, *Richard Evans Schultes & Isidoro Cabrera 13353.*

Styracaceae

Styrax rigidifolius *Idrobo & R. E. Schultes* forma **yapobodensis** *Idrobo & R. E. Schultes* in Bot. Mus. Leafl. Harvard Univ. 13 (1949) 332, t. 38, figs. g, h.

Styrax yapobodensis (Idrobo & Schultes) Steyermark in Fieldiana 28 (1953) 492.

The collection *Schultes & Cabrera 18311* amplifies the known distribution of this unusual treelet, whereas *Schultes & Cabrera 20012* represents topotypical material. A study of both collections indicates that the characters

upon which the *forma* is based are stable, albeit of a minor nature.

COLOMBIA: Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs about 15 miles upstream from mouth. Quartzite base. Alt. about 800–900 ft. General location: Lat. 1°0′ N, Long. 70°15′ W. November 10, 1952, *Richard Evans Schultes & Isidoro Cabrera 18311.*—Comisaría del Vaupés, Río Kuduyarí (tributary of Río Vaupés), Yapobodá. Quartzite savannah near headwaters. Alt. about 900–1000 feet. General location: Lat. 1°20′ N, Long. 70°30′ W. "Small treelet, up to 8 feet tall." April 1953, *Schultes & Cabrera 20012.*

SAPOTACEAE

Pouteria Ucuqui *Pires & R. E. Schultes* in Bot. Mus. Leafl. Harvard Univ. 14 (1950) 87, tt. 20, 21, 22, 23.

This gigantic forest tree, the fruits of which are eagerly sought for food by the natives (Pires & Schultes *loc. cit.*), has hitherto not been reported from such westerly localities in the Amazon basin. It is not uncommon in the middle and lower courses of the Río Apaporis of Colombia.

The following Indian names may now be recorded for *Pouteria Ucuqui:* Tukano=*poo-pee-á;* Kuripako=*heé-ne-ree;* Puinave=*bee;* Kubeo=*pá-ko-ra;* Maku (of Río Piraparaná)=*foó-hee-ya.* The Brazilian name *ucuquí* is known and used by many Indians and white settlers on the Colombian side of the boundary between Brazil and Colombia. Colombians in settlements where Brazilian is not understood or spoken use the term *yucu* for the tree.

COLOMBIA: Comisarías del Amazonas-Vaupés, Río Apaporis, Soratama (above mouth of Río Kananarí) and vicinity. Alt. about 900 feet. General location: Lat. 0°5′ N, Long. 70°40′ W. February 6, 1952, *Richard Evans Schultes & Isidoro Cabrera 15177.*—Comisarías del Amazonas-Vaupés, Río Apaporis, Jinogojé (at mouth of Río Piraparaná) and vicinity. Alt. about 700 feet. General location: Lat. 0°15′ S, Long. 70°30′ W. "Large tree." July 1952, *Schultes & Cabrera 19784.*

LOGANIACEAE

Pagamea coriacea *Spruce ex Bentham* in Journ. Linn. Soc. 1 (1857) 110.

The type of this rare bush was collected by Spruce on the Rio Negro in Brazil. The known range of the species is appreciably widened to the west by the Colombian material cited below. The genus *Pagamea* has not hitherto been reported from Colombia.

COLOMBIA: Comisarías del Amazonas-Vaupés, Río Apaporis, Raudal de Jirijirimo (below mouth of Río Kananarí). Alt. about 900 feet. General location: Lat. 0°5′ N, Long. 70°40′ W. "Bush, 10 feet tall. Axes red. Flowers white." January 21, 1952, *Richard Evans Schultes & Isidoro Cabrera 14933.*—Same locality and date. "Bush. Flowers rare, white. Common on savannahs. Full, up to 12 feet tall." *Schultes & Cabrera 14953.*—Same locality. "Large bush. Fruit green. Axes red." March 15, 1952, *Schultes & Cabrera 15931.*—Comisaría del Vaupés, Río Karurú (tributary of Río Vaupés), Mesa de Yambí, savannah Goo-ran-hoo-da. Alt. about 950–1000 feet. General location: Lat. 1°20′ N, Long. 71°20′ W. April 15–16, 1953, *Schultes & Cabrera 19169.*—Comisaría del Vaupés, Río Paraná Pichuna (tributary of Río Vaupés). Alt. about 700 feet. General location: Lat. 1°10′ N, Long. 70°30′ W. "Bush. Fruit dark blue-black." June 1953, *Schultes & Cabrera 19921.*

Pagamea macrophylla *Spruce ex Bentham* in Journ. Linn. Soc. 1 (1857) 110.

Pagamea macrophylla, the type of which was collected at Ipanoré on the Rio Uaupés of Brazil, near the Colombian frontier, is a much rarer plant than *P. coriacea*. I have never seen these two caatinga-plants growing together. The former inhabits apparently only the light, shaded forest which rims the open, sandy savannahs, whereas the latter is at home exclusively in the sunniest parts of the savannahs or caatingas, where the vegetation is at most shrubby.

COLOMBIA: Comisaría del Vaupés, Río Piraparaná (tributary of Río Apaporis), Caño Paca. General location: between Lat. 0°15′ S, Long. 70°30′ W and Lat. 0°25′ N, Long. 70°30′ W. "Small treelet." September 19, 1952, *Richard Evans Schultes & Isidoro Cabrera 17581.*

GENTIANACEAE

Halenia Weddelliana *Gilg* in Engler Bot. Jahrb. 25 (1898) 724.

In trying to identify a number of plants from Cauca (cf. Agric. Trop. 11 (1955) 471) which the late Colombian poet, Dr. Guillermo Valencia, mentioned in a letter by their vernacular names, we were unable to determine "yerba de venado." A letter to Dr. Alvaro Fernández of the Instituto de Ciéncias Naturales of Bogotá, a student of the flora of Cauca, led to his discovery that the natives of the Hacienda de Paletará refer to *Halenia Weddelliana* as *cacho de venado* ("deer horn") and that they value the plant for treating venereal diseases. This interesting use must be of long standing and widespread in Cauca, for a synonym of *Halenia Weddelliana* is *H. antigonorrhoica* Gilg.

Halenia Weddelliana is not uncommon in southern Colombia (Cauca and Nariño), Ecuador and Perú.

COLOMBIA: Departamento del Cauca, Hacienda de Paletará. Alt. about 3000 m. "Hierba en potreros. Flores verde-amarillento. Usada por los nativos para tratar enfermedades venéreas. *Cacho de venado.*" January 3, 1954, *A. Fernández 2653*.

SOLANACEAE

Solanum apaporanum *R. E. Schultes* in Bot. Mus. Leafl. Harvard Univ. 13 (1949) 292.

The type of this unusual species was collected in the upper course of the Río Apaporis. The second and third collections, *Schultes & Cabrera 12717* and *19828*, establish its occurrence likewise in the lower course of the same river, some 1,000 kilometers downstream.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, entre el Río Pacoa y el Río Kananarí, Soratama. Alt. ca. 250 m. "Vine. Flowers white; anthers yellow. Flood-bank." June 21, 1951, *Richard Evans Schultes & Isidoro Cabrera 12717*.—Comisarías del Amazonas-Vaupés, Río Apaporis, Jingojé (at mouth of Río Piraparaná) and vicinity. Alt. about 700 feet. General location: Lat. 0°15′ S, Long. 70°30′ W. March 1952, *Schultes & Cabrera 19828*.

Bignoniaceae

(Contributed by N. Y. Sandwith)

Tabebuia subtilis *Sprague & Sandwith* var. **Schultesiana** *Sandwith var. nov.*

A *T. subtili* pilis lateris interni corollae tubi atque zonae infra insertionem staminum ad papillas breves obtusas redactis differt.

This material has the main characteristics of *Tabebuia subtilis*, which is a similar small tree growing in the same type of habitat — on rocks by rapids — in the Potaro River Valley in British Guiana. It differs in the pubescence of the interior of the corolla tube, which is reduced to very short and blunt papillae, whereas, in typical *Tabebuia subtilis*, this pubescence is composed of long papilla-like hairs. No fruit is present in the Colombian material which, I am convinced, is most prudently treated, on the evidence, as a variety of *Tabebuia subtilis*.

Colombia: Comisarías del Amazonas-Vaupés, Río Apaporis, Raudal Yayacopi (La Playa) and vicinity. Quartzite base; alt. about 800 ft. "A small scraggly tree. Flowers yellow." April 15, 1952, *Richard Evans Schultes & Isidoro Cabrera 16195* (Type in Herb. Kew).

Rubiaceae

Platycarpum Schultesii *Steyermark sp. nov.*

Frutex, ramis lignosis pubescentibus, vetustioribus scabrido-hirtellis, juvenilibus hirtello-hispidulis; foliis plerumque ternatis, rarius oppositis, coriaceis, petiolatis, petiolis 3–7 mm. longis, dense hirtellis; laminis elliptico-oblongis vel elliptico-oblanceolatis, obtusis vel subobtusis, basi acutiusculis, 8–14 cm. longis, 2–5 cm. latis, supra aspero-scabridulis, costa media dense hirtella, subtus dense velutino-hirtellis, pallidioribus, nervis lateralibus utroque latere 11–13 subtus prominentibus; thyrsis terminalibus, multifloris, pyramidalibus, trichotomis, 5–8 cm. longis; pedunculis 4–5 cm. longis, hirtello-hispidulis; bracteis subulatis, acutis, 5–6 mm. longis, 1 mm. crassis,

hispidulis; calyce 9–10 mm. longo, extus roseo-purpureo, cano-tomentello strigillosoque, intus tomentello, tubo 4–5 mm. longo, lobis 5 paullo inaequalibus, oblongo-oblanceolatis, subacutis, 7–8 mm. longis, 3–3.75 mm. latis; corollis infundibuliformibus, 10 mm. longis, extus albo-sericeis, intus lobis purpureo-maculatis, glabris, tubo intus papillato, fauce dense barbato-hirsuto; antheris anguste oblongis, apiculatis, 3.5 mm. longis; filamentis glabris, 3 mm. longis; nectariis prominentibus, 10, cano-tomentellis; ovario subinferiore, apice cano-hirsuto, stigmate 2-fido, stylo 4.5 mm. longo, glabro; capsula juventute dense fulvo-tomentosa, compressa, rotundato-obreniformi, 2.5 cm. alta, 2.5–2.7 cm. lata.

This is the first record of the genus *Platycarpum* from Colombia. The new species is related to *Platycarpum orinocense* HBK. and to *P. Duckei* Steyermark, but, unlike these species, it has mostly ternate instead of opposite leaves. The flowers are considerably smaller than in either of those species, and the pubescence is of a much shorter type than that found in either *Platycarpum orinocense* or *P. Duckei*. The scabridulous upper leaf-surface of *Platycarpum Schultesii* resembles most closely the type of pubescence found in *P. Duckei*, but the former species differs from the latter, among other particulars, in the short pubescence of the lower leaf-surface and of the petioles and rachis. The only other species of *Platycarpum* with ternate leaves is *P. rhododactylum* Woodson & Steyermark of Venezuela.

Colombia: Comisaría del Vaupés, Río Paraná Pichuna (tributary of Río Vaupés). Alt. about 200 meters. General location: Lat. 1°10′ N, Long. 70°30′ W. June 1953, *Richard Evans Schultes & Isidoro Cabrera 19929* (Type in Herb. Chicago Mus. Nat. Hist.).

Compositae

Gongylolepis Martiana (*Baker*) *Steyermark & Cuatrecasas* in Fieldiana 28 (1953) 640.

Gongylolepis maroana Badillo in Bot. Soc. Venez. Ciénc. Nat. 8 (1943) 237.

Collections of *Gongylolepis Martiana* from Colombia have recently been reported as *G. maroana* Badillo (Schultes in Bot. Mus. Leafl. Harvard Univ. 13 (1949) 310; *ibid.* 14 (1949) 47; *ibid.* 16 (1953) 95). In pointing out the synonymy of *Gongylolepis maroana* and *Stifftia Martiana* Baker, Steyermark and Cuatrecasas (Steyermark *loc. cit.*) state that Maroa (a Venezuelan town on the Río Guainía), the type locality of *Gongylolepis maroana*, "is near the type locality (Prov. Alto Amazonas, in . . . montis Araracuara, 500 pedes supra fluvius Japurá) in Brazil, where Martius collected *Stifftia Martiana.*" There are several errors in this statement that require rectification. Although in the days of Martius' collecting, one hundred and thirty years ago, Brazil laid claim to the Amazon as far west as Araracuara, this now-famous locality has been under undisputed Colombian sovereignty for much more than half a century and lies some 350 kilometers from the Colombian-Brazilian frontier. The continued citing of specimens from Araracuara as Brazilian creates serious problems in our studies of Amazonian phytogeography. The statement that Maroa is near Araracuara is misleading, for the straight distance is some 650 kilometers, and they lie in different river valleys. Furthermore, Maroa lies on the granitic Brazilian shield of Pre-Cambrian age, whereas the mountains of Araracuara, where *Gongylolepis Martiana* is known to grow, are metamorphic quartzites of Cretaceous age. The presence of the same species on both of these formations is unusual, though not unique.

The collections cited previously and those cited below from Colombia show that the concept is widely dispersed on the remnant Cretaceous hills in the Amazonian basin of that country: *Allen 3167* (Yurupari Falls, Río

Vaupés); *Schultes 5740a* and *5742* (Cerro Chiribiquete); *Schultes 5568* (Cerro de La Campana); *Schultes 5816* (Caño Paca, Río Vaupés).

Colombia: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri. Near summit. "Ten feet tall." January 23–25, 1952, *Richard Evans Schultes & Isidoro Cabrera 15033.*—Comisaría del Vaupés, Río Kubiyú (tributary of Río Vaupés), Cerro Kañendá. Savannahs 15 miles upstream from mouth. Quartzite base. Alt. about 800–900 feet. General location: Lat. 1°0′ N, Long. 70°15′ W. November 10, 1952, *Schultes & Cabrera 18326.*—Comisaría del Vaupés, Río Karurú (tributary of Río Vaupés), Mesa de Yambi. Savannah Goo-ran-hoo-da. Quartzite base. Alt. about 950–1000 feet. General location: Lat. 1°20′ N, Long. 71°20′ W. "Bush." April 15–16, 1953, *Schultes & Cabrera 19137.*—Comisaría del Vaupés, Río Vaupés, Raudal de Yuruparí. Quartzite base. General location: Lat. 0°40′ N, Long. 70°30′ W. November 1951, *Schultes & Cabrera 19719.*

Stenopadus colombianus *Cuatrecasas & Steyermark sp. nov.*

Arbor 4 m. alta, ramis terminalibus subteretibus, in sicco cortice plusminusve plicato, ochraceo-brunneis, adpressissime squamoso-strigosis, squamis subulatis. Folia alterna, petiolata, petiolo 3–4 cm. longo, 3–4.5 mm. crasso, in sicco rugoso-striato, adpressissime squamoso-strigoso, basi longe decurrenti. Lamina magna, firme coriacea, elliptico-oblonga vel obovato-oblonga, margine integra leviter revoluta, apice subito breviterque apiculata vel obtusa vel subrotundata, 13–32 cm. longa, 6–14 cm. lata; utrinque aspectu glaberrima sed pilis minutis squamosis malpighiaceis atro-fuscis sparsissimis, ad costam copiosioribus, praedita; supra pallido-viridis, costa laxo reticulo nervorum valde prominenti notata; infra costa crasse elevata, nervis secundariis 9–15 utroque latere elevatis, reticulo nervorum prominulo laxoque. Capitula solitaria, terminalia, sessilia, praecipue 35 floribus. Involucrum circa 4 cm. altum, cylindrico-campanulatum, basi rotundatum, phyllaribus 6–7 seriatis, subcoriaceis, rigidis, exterioribus rotundato-ovatis vel ovatis, 15–18 mm. longis,

10–11 mm. latis, basi valde incrassatis, basilaribus brevioribus, squamoso-tomentellis, intermediis gradatim imbricatis, ovato-oblongis vel oblongis, rotundatis vel obtusis, 18–25 mm. longis, 7–10 mm. latis, intimis linearibus, apice acutis vel acutiusculis, 32–35 mm. longis, 4–5 mm. latis, omnibus margine breviter ciliatis, dorso glabris, in sicco olivaceis. Paleae receptaculi numerosae, subulatae, apicem versus puberulae, margine ciliolatae, reliquae glabrae, 35 mm. longae, 0.5–1.5 mm. latae. Corolla actinomorpha, purpurea, glabra, tubo circa 22 mm. longo, apicem versus infundibuliformi, laciniis anguste linearibus, valde revolutis, 14–16 mm. longis, 1 mm. latis. Antherae 12 mm. longae, caudiculis linearibus, subacutis, 2.5 mm. longis. Ovarium nigrum, glabrum, 3–4 angulatum. Pappus circa 24 mm. longus, pallido-brunneus, tenuiter breviterque barbellatus.

This is the first record of the genus *Stenopadus* from Colombia. In Maguire's treatment (Mem. N.Y. Bot. Gard. 8 (1953) 153), *Stenopadus colombianus* would come nearest to *S. talaumifolius* Blake and *S. cardonae* Mag. & Lasser (=*S. talaumifolius* var. *magnifolius* Steyermark). From both of these species it differs in its much larger leaf-blades, more numerous flowers in a head, nearly glabrous involucre, the squamo-strigosity of the branches and petioles, and the sparsely dispersed malpighiaceous hairs on the leaves.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, Cerro Isibukuri, near summit. January 23–25, 1952, *Richard Evans Schultes & Isidoro Cabrera 15031* (TYPE in Herb. Chicago Mus. Nat. Hist.).

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ESTIMATES OF TEOSINTE INTROGRESSION IN ARCHAEOLOGICAL MAIZE

BY

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IN their monograph, "The Origin of Indian Corn and Its Relatives," Mangelsdorf and Reeves (1939) postulated that teosinte (Euchlaena) is the descendant of a natural hybrid between maize (Zea) and its wild relative Tripsacum, and that subsequent introgression from teosinte (i.e., ultimately from Tripsacum) has contributed significantly to the development of modern maize. The first of these postulates has not yet been proven, but evidence in support of the second has recently been found, not only in living races of maize, but also in archaeological remains of this economic plant. Studies of Wellhausen *et al.* (1952) indicate that the modern races of maize in Mexico have varying degrees of teosinte introgression, and that the most productive of these races were derived by combining different lines of introgression. In the prehistoric cobs from Bat Cave, which Mangelsdorf and Smith studied (1949), the earliest specimens appear to be "pure" maize, whereas later ones show evidence of contamination by teosinte. Further evidence of prehistoric introgression by teosinte comes from the upper

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strata of maize remains in nearby Tularosa Cave studied by Cutler (1952). At least three of the Tularosa Cave cobs illustrated by Cutler appear to be highly "Tripsacoid" (a term used first by Anderson and Erickson in 1941 to describe maize which tends, in some of its characteristics, to resemble Tripsacum). Also, some of the prehistoric cobs from the Hueco Mountain Caves in western Texas, as illustrated by Cosgrove (1947, Fig. 65), resemble those of Tripsacoid maize.

Archaeological material recently excavated from two caves in Arizona has yielded more abundant evidence on the role of teosinte (or Tripsacum) in the evolution of modern maize. This material, collected by the junior author, Mr. Lloyd Pierson, comes from Richards' Caves near Montezuma Castle and from the lower ruin in the Tonto National Monument in Arizona. It consists of the unusually large total of 3,342 well-preserved cobs, as well as numerous kernels, husks, shanks and tassel fragments. Its age is estimated at from 500 to 700 years.

Among the cobs are specimens which resemble closely those which occur in the F_2 and backcross generations of maize-teosinte hybrids. In fact, it is possible to match many of these archaeological specimens, feature for feature, with modern cobs of segregates of maize-teosinte hybrids (Plates XXV and XXVI). These Tripsacoid cobs tend to be more indurated than the "pure" maize cobs in the same collection. This is regarded as highly significant, for one of the conspicuous differences between maize and its two relatives, teosinte and Tripsacum, is in the induration of the tissues, especially those of the rachis, cupule[1] and lower glumes. In both teosinte and Tripsacum, the caryopsis is enclosed in a hard, bony case

[1] The cupule or alveolus is a lignified structure thought to represent a prophyll adnate to the rachis, and to be borne on a reduced primary branch which bears a pair of pistillate spikelets (Nickerson, 1954).

composed of an internode of the rachis, a cupule and the lower glume. These structures become highly lignified as the fruit matures. Extensive experiments with maize-teosinte hybrids have demonstrated that the genes responsible for the lignification occur on many, if not all, of the chromosomes of teosinte. Indeed, in segregating generations of maize-teosinte hybrids, it is difficult to find individuals, even the most maize-like, which do not exhibit some degree of lignification of the rachis, cupule and lower glumes. Consequently, when in archaeological cobs strong induration (lignification) of these structures is encountered, teosinte introgression is at once suspected, especially when such induration is accompanied by solitary spikelets and two-ranked spikes, both teosinte characters, as is the case in some specimens. Unfortunately, the seeds of archaeological maize are not viable and it is not possible to obtain direct and final proof through breeding experiments. However, all of the facts presented here are consistent with the hypothesis that there has been such introgression.

Inasmuch as the hybridization of maize and Tripsacum has never been observed in nature and is, at best, rare, and since teosinte and maize do hybridize regularly in Guatemala and Mexico, we may, for the purposes of this discussion, assume that the prehistoric introgression represented by these archaeological specimens comes from teosinte rather than from Tripsacum and that this hybridization occurred in Mexico. We are left, however, with the possibility that maize has hybridized with local species of Tripsacum in the American Southwest and that the introgression involved is directly from Tripsacum, rather than indirectly through teosinte.

Specific Gravity of Teosinte Derivatives and Archaeological Cobs

Since the cobs of derivatives from maize-teosinte hy-

brids are more highly lignified and more dense than those of ordinary maize, it was hoped that a fairly direct estimate of teosinte introgression might be made by determining the specific gravity of the cobs. This proved for various reasons (for example, the presence or absence of pith) not to be the case. Nevertheless, it was found that in modern maize the specific gravity increases with known additions of teosinte germplasm; and that, among archaeological cobs, the Tripsacoid specimens have a significantly higher specific gravity, on the average, than the non-Tripsacoid ones.

Specific gravity was determined by liquid displacement, using a ten percent solution of alcohol as the liquid. The modern maize tested comprised single crosses of the inbred strains K155, L317, 701 and 38-11 with 4R-3 and with modified strains of 4R-3, in which two or three chromosomes of teosinte had been introduced through repeated backcrossing.

The data (Table I) indicate a significant positive relationship between degree of teosinte introgression and specific gravity. The more Tripsacoid cobs, in this case those known to have teosinte introgression, have a significantly higher specific gravity than the controls.

In archaeological maize, a parallel experiment was conducted by substituting estimates of the induration of the

TABLE I. Average specific gravity of cobs as compared to number of teosinte chromosomes in modern maize and degree of induration in archaeological maize.

Modern Cobs		Archaeological Cobs	
No. teosinte chromosomes	Av. sp. grav.	Grade of induration	Av. sp. grav.
0	.620	2	.658 ± .01
2	.680	3	.657 ± .01
3	.740	4	.690 ± .01 *

* Grade-4 is significantly greater than either grades-2 or 3

cob for known teosinte introgression and correlating it to specific gravity. The archaeological material consisted of 217 cobs from Richards' Caves. Since induration is a subjectively determined character, all estimates were made by one person. Specific gravity determinations were made as with the modern specimens. Here again, the difference is significant, although the increase in specific gravity is not so great and is limited to the highest grade of induration. The curve expressing this relationship (Table I) would resemble that used by Anderson and Erickson (1941) to illustrate their hypothesis of antithetical dominance (a hypothesis suggesting that modifier complexes with sharp threshold effects control dominance of certain characters in wide hybrids).

Tests for Lignification in Teosinte Derivatives and Archaeological Cobs

Since cellulose is easily dissolved by concentrated sulphuric acid while lignified tissues are resistant, treatment with this acid is recognized as a specific test for lignin. It has been found that, when cobs of teosinte derivatives are so treated, they lose all of their tissues except the rind and cupules of the rachis and the lower glumes. When archaeological specimens are subjected to the same treatment, immersed for twenty-four hours in sulphuric acid, the Tripsacoid cobs remain almost intact, while the pure maize cobs disintegrate to a delicate framework of cupule margins (Plate XXVII).

It has already been mentioned that both modern and archaeological Tripsacoid cobs have a higher specific gravity than the non-Tripsacoid cobs. None of these facts in itself proves that the cobs in question are a product of maize-teosinte hybridization; but, together, they provide a reasonable presumption that such might be the case.

Estimates of Teosinte Introgression

Since the archaeological Tripsacoid cobs, like modern maize-teosinte derivatives, have a higher specific gravity than non-Tripsacoid ones and are more resistant to erosion by sulphuric acid, it is assumed for the purposes of this study that induration of the tissues of the cob is a rough measure of teosinte introgression. Estimates of introgression were made with an arbitrary key of five grades. Grade-1 designates the pure maize extreme while grade-5 approaches a maize-teosinte F_1 hybrid (Plate XXVIII). Although the degree of induration is the chief factor, single-pistillate spikelets distinguish the highest grade. Single-pistillate spikelets are characteristic of teosinte and are common in maize-teosinte hybrids, but absent in typical maize.

Other Characters Studied. Cob size has a particular interest for these studies, since previous work on archaeological maize indicates that an enlargement of the cob has been an outstanding feature of maize evolution (Mangelsdorf and Smith, 1949; Mangelsdorf, 1954). Both length and diameter of cob were measured. Other characters chosen for analysis were kernel-row number and fasciation. In smaller samples of the collection, the following internal characters were also studied: pilosity, cupule width, glume length and rachis diameter. Average estimates of teosinte introgression (average induration score) were determined for each morphological class by the use of key-sort cards. Correlation coefficients were then calculated and the data were plotted in curves. In the case of kernel-row number, however, the effects of teosinte introgression were studied independently for the fasciated and non-fasciated cobs. This distinction was made because fasciation is known to have an effect of its own on row-number.

The following procedures were observed in scoring the cob characters: 1) The number of rows of pistillate spikelets (kernel-row number) was counted in the central region of all intact and fragmentary cobs; 2) A fasciated cob was considered to be any cob which was obviously flat for at least one-quarter of its length. This flattening was generally observed at the tip of the cob where it is most frequent. Fasciation was not scored in the four-row class, although such cobs are at least superficially flat as a result of their bilateral nature; 3) Diameters were measured in the central region of all intact and fragmentary cobs. When cobs were fasciated, the average of maximum and minimum widths was used; 4) Length measurements were made only on obviously intact specimens (about one-third of the collection); 5) The internal characters (pilosity, cupule width, glume length and rachis diameter) were determined for a random sample of fourteen intact cobs from each grade of introgression. Pilosity was scored in six grades, the higher numbers indicating stronger pubescence. Cupule width was measured between the lateral wings or "rachis flaps" of the cupule.

Richards' Cave Maize

1,440 cobs were obtained from two of Richards' Caves. One of these caves was subdivided into five areas. Since the variability and averages of the data for these areas are similar, this collection has been treated as a whole (Table II).

Kernel-row Number. Teosinte introgression causes a decrease in row-number for all cobs from Richards' Caves, except non-fasciated ones that are above average in row-number (Table III). In these exceptional cobs, the initial relationship is reversed by an increase in introgression with row-numbers from twelve to sixteen,

TABLE II. Morphological characteristics of two populations of archaeological maize cobs

		Richards' Caves						Tonto		
		Cave I	Cave II							
			Room 1			Room 4	Room 6	Room 16	Area-A	Area-B
			Above floor	Cyst 1	Cyst 2					
No. cobs		150	880	160	30	20	187	1502 *	343 **	57
Intact	%	29	34	19	23	10	28	9	6	12
Red	%	9	4	7	17	10	7	5	7	—
Fasciated	%	—	16	13	13	40	11	23	26	28
Unusual	%	1	15	12	13	20	12	4	6	12
(%) Teosinte Introgression	1	1	0.1	—	—	—	—	3	—	—
	2	21	16	23	11	21	20	25	14	13
	3	55	64	56	66	74	50	60	77	76
	4	23	19	21	23	5	29	12	10	11
	5	—	1	—	—	—	1	—	—	—
No. of Kernel Rows (%)	4	1	1	—	3	—	—	1	—	2
	6	—	1	—	3	—	1	—	—	—
	8	19	31	33	40	25	23	23	30	25
	10	35	33	22	30	30	36	53	55	40
	12	31	23	21	23	45	26	20	16	26
	14	7	8	16	3	—	10	3	5	7
	16	4	2	7	—	—	3	1	—	—
	18	1	1	—	—	—	1	—	—	—

Diameter mm. (%)	5	1	—	1	—	—	—	—	—	—
	10	11	9	12	7	15	19	12	8	32
	15	59	36	28	33	25	32	46	61	46
	20	40	38	34	43	45	33	34	29	23
	25	15	13	16	17	15	11	6	3	—
	30	2	3	7	—	—	4	2	—	—
	35	1	1	1	—	—	1	—	—	—
	40	1	—	1	—	—	—	—	—	—
Length cm. (%)	3	—	0.4	—	—	—	—	1	—	14
	4	9	5	—	—	—	—	4	—	—
	5	9	11	6	14	—	—	13	20	—
	6	14	19	13	14	—	12	10	25	14
	7	11	10	13	—	50	13	19	—	—
	8	5	13	10	30	—	19	10	20	14
	9	11	10	3	—	—	12	7	20	29
	10	5	8	16	14	—	12	11	5	29
	11	20	6	—	—	50	8	12	10	—
	12	2	5	10	—	—	4	4	—	—
	13	—	4	13	—	—	6	3	—	—
	14	2	3	10	14	—	4	4	—	—
	15	2	2	6	14	—	4	1	—	—
	16	2	2	—	—	—	4	—	—	—
	17	2	1	—	—	—	—	—	—	—
	18	—	—	—	—	—	2	—	—	—
	19	5	0.4	—	—	—	2	—	—	—

— Absent

* Data from 16% of population
** Data from 66% of population

and finally a decrease at eighteen rows (Fig. 1).

The general effect of introgression in reducing row-number appears to have a secondary effect in reducing the amount of fasciation. This is suggested by the fact that fasciation is significantly less frequent in Tripsacoid cobs (fourteen percent in grade-4) than in non-Tripsacoid ones (seventeen percent in grades-2 and 3). Apparently such an effect accentuates a tendency for fasciation to be concentrated in the high row-number, non-Tripsacoid cobs.

Diameter. Cob diameters in the Richards' Caves collection average 18.3 mm. Teosinte introgression has no significant effect on diameter in this population (Table III and Fig. 2).

Length. The length of 433 intact specimens from Richards' Caves averages 8.74 cm. The average in this case has little meaning, since, as is shown later, at least two factors are interacting to produce the variation in this collection. The longest and shortest cobs are the most Tripsacoid (Fig. 3 and Plate XXVIII). The fitness of the data to a parabolic curve is excellent (Table III).

Internal Characters. Teosinte introgression appears to affect the internal characters of the cobs from Richards' Caves as follows: it decreases pilosity, increases cupule width, and increases glume length. Rachis diameter and glume-rachis ratio appear not to be closely associated with introgression in the samples studied (Table IV).

Kernels. A majority of the 140 mature kernels from Richards' Caves have a yellow, flinty endosperm; the remainder are floury. A few of both types have a red pericarp. The dimensions (Table V) show that the grains are quite uniform in size and probably are too large to pop. Almost half of the grains are definitely immature.

TABLE III. Test for significance of correlations between Teosinte introgression and kernel rows, diameter and length for cobs from Richards' Caves.

Character	Correlation	d.f.	Probability
Kernel rows *	-0.851 [1]	5	$<.05$
Diameter	0.075 [1]	6	$>.05$
Length	0.859 [2]	14	$<.01$

* Fasciated cobs

[1] Linear

[2] Parabolic curvilinear

TABLE IV. Certain internal characters for samples of 14 intact cobs from various levels of teosinte introgression in Richards' Caves maize.

Introgression [1]	Pilosity [2]	Cupule width (mm.)	Glume Length (mm.)	Rachis Diameter (mm.)	G/R Ratio
2	5.0	7.0	3.0	10	.30
3	4.3	7.3	4.0	11	.36
4 (long) [3]	2.3	9.7	4.2	15	.28
4 (short) [4]	1.8	9.1	4.2	10	.42

[1] Grade-5 is most tripsacoid

[2] Grade-5 shows strongest pubescence

[3] Av. length 13.5 cm.

[4] Av. length 4.0 cm.

TABLE V. Frequency and average dimensions (mm.) of various types of caryopses from Richards' Caves.

Type	Frequency	Length	Width	Thickness
Flour – Y	14	8.0	8.5	6.1
Flour – P	4	7.5	8.5	5.5
Flint – Y	121	7.5	8.5	5.7
Flint – P	1	8.0	9.0	5.8
Immature	100	—	—	—

Y – yellow endosperm, colorless pericarp

P – red pericarp

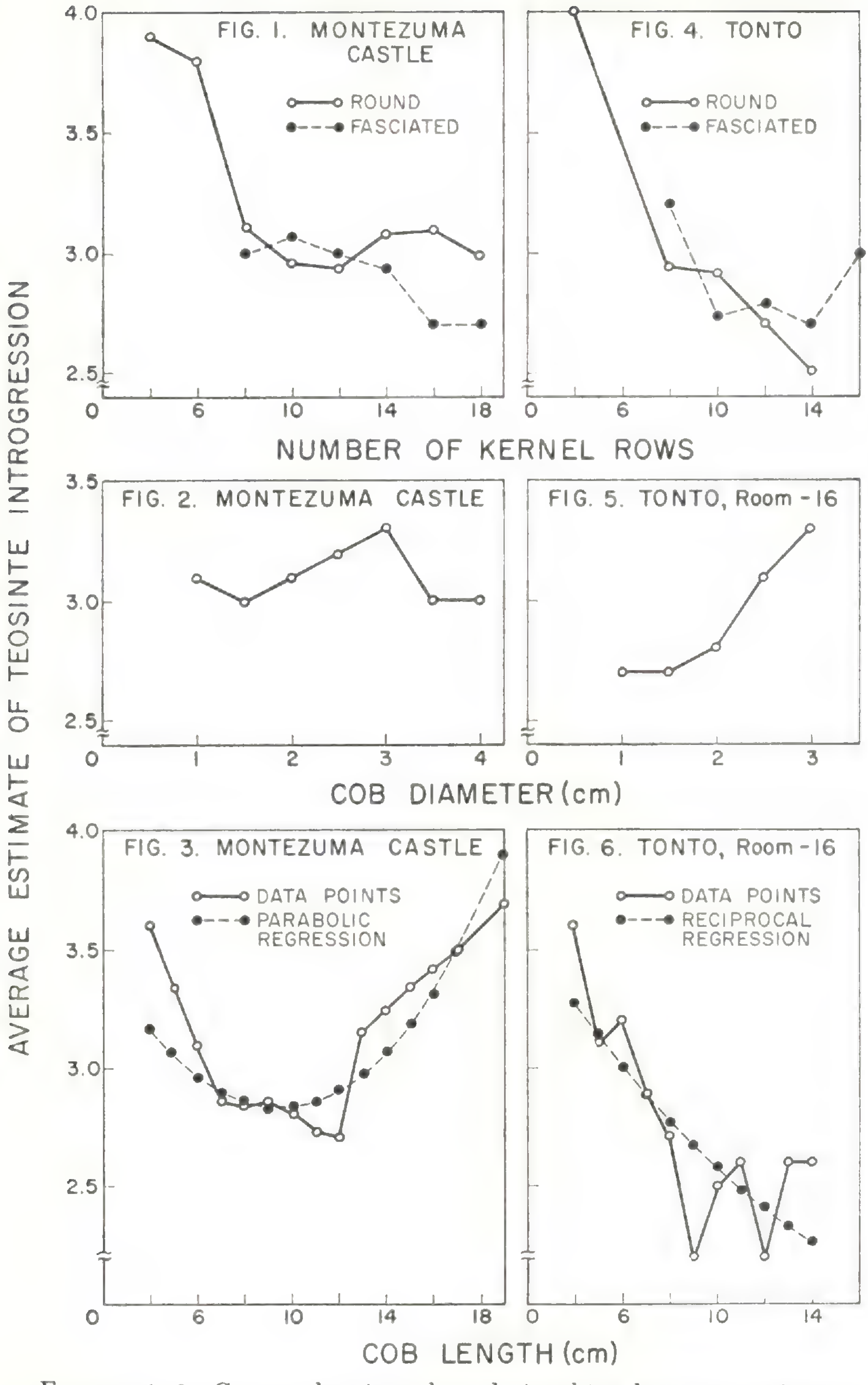
This suggests that some of the ears were consumed in the green or roasting stage.

Tonto Maize

This lot of 1902 cobs was obtained from three areas. The majority (seventy-nine percent), however, came from a single location (Room 16). The material may therefore be considered as a unit (Table II). Analysis was restricted to a representative sample of 500 cobs (twenty-six percent of the total), which included all intact specimens (162 cobs). The cobs are relatively uniform and many are broken. Increased breakage in the Tonto cobs (ninety-one percent as compared to seventy percent for Richards' Caves) may be attributed to a significantly lower level of teosinte introgression (Table VI).

Kernel-row Number. Kernel-row number in non-fasciated cobs decreases significantly with increasing levels of introgression. In contrast to this, the row-number of fasciated cobs appears to be independent of introgression, or at least the relationship is complicated by other factors (Table 7 and Fig. 4). Fasciation is more common at Tonto (twenty-five percent as compared to fourteen percent for Richards' Caves) and is associated with pure maize (twenty-eight percent fasciation at grade-2; twenty-five percent at grade-3; and eleven percent at grade-4). At the average row-number of ten, fasciation prevails in twenty-three percent of the cobs (a frequency twice as high as in the ten-rowed cobs from Richards' Caves, and many times that which is characteristic of most modern races).

Diameter. Tonto cobs are slender, averaging only 16.5 mm. in diameter (2 mm. less than in Richards' Caves). Teosinte introgression increases the diameter of these cobs (Table VII and Fig. 5).



FIGURES 1–6. Curves showing the relationships between estimates of teosinte introgression and various cob characters for Richards' Caves [indicated above as Montezuma Castle] and Tonto maize.

Length. The length of intact cobs from Tonto averages 8.3 cm. (0.5 cm. less than in cobs from Richards' Caves). Teosinte introgression causes a general decrease in cob length. This relationship is best illustrated by a reciprocal regression curve, rather than by a straight line (Table VII and Fig. 6).

Kernels. The 511 kernels recovered from Tonto are largely of a yellow, flinty type; the remainder being floury. A few of both types have red or cherry-colored pericarps (in solid and variegated patterns). Forty-three flinty grains have their embryos and pericarps removed, perhaps in preparation for grinding. All kernels are mature, uniform, and too large for good popping (Table VIII).

Unusual Specimens

Cobs with unusual morphological characteristics were found in both collections. These distinguishing features include: long glumes; "Siamese" twinning (duplication of rachis followed by incomplete divergence); lateral fusion of cupules (15 laterally-fused cupules found in one spiral); solitary cupules terminal to the cob and free from adjoining rachis tissue; close similarity to maize-teosinte hybrids; unusual extremes in size, fasciation, etc.

Prehistoric Tunicate Maize. One of the few archaeological specimens known to duplicate the extreme form of modern tunicate maize occurs among the long-glumed cobs (Plate XXIX). A similar specimen has previously been reported by Cutler (1944) from the Betatakin Pueblo Ruin near the San Juan River in Arizona. Our tunicate specimen, as well as five other long-glumed cobs from Richards' Caves, are Tripsacoid (Table IX). The actual level of introgression in these cobs may be partially masked by the tunicate condition. Thus, their esti-

TABLE VI. Comparison between certain morphological features of Richards' Caves and Tonto maize cobs.

	Richards' Caves	Tonto	t-value	d.f.	Probability
Teosinte Int.	3.03	2.89	5.02	1901	<.01
Kernel Rows	10.36	10.04	2.76	1890	<.01
Diameter (mm.)	18.27	16.46	7.66	1917	<.01
Length (cm.)	8.74	8.26	1.52	593	>.05

TABLE VII. Test for significance of correlations between Teosinte introgression and kernel rows, diameter and length for Tonto cobs.

Character	Correlation	d.f.	Probability
Kernel rows			
(a) fasciated cobs	0.296 [1]	4	>.05
(b) round cobs	-0.951 [1]	4	<.01
Diameter	0.984 [1]	4	<.01
Length	0.725 [1]	10	<.01
Length	0.978 [2]	10	<.01

[1] Linear

[2] Reciprocal curvilinear

TABLE VIII. Frequency and average dimensions (mm.) of various types of caryopses from Tonto.

Type	Frequency	Length	Width	Thickness
Flour – Y	13	8.0	9.0	5.8
Flour – P	9	8.3	8.0	6.2
Flint – Y	374	8.0	8.0	4.8
Flint – P	72	7.5	8.0	5.1
Fragments	43			

Y – yellow endosperm, colorless pericarp

P – red or cherry (solid or variegated) pericarp

mated introgression score is probably lower (closer to pure maize) than is really the case. Such a possibility is suggested by comparisons of cupule width and pilosity between the tunicate and non-tunicate cobs (Tables IV and IX).

TABLE IX. Certain internal characters of tunicate-like cobs from Richards' Caves maize.

Cob No.	Introgression[1]	Pilosity[2]	Cupule Width (mm.)	Glume Length (mm.)	Rachis Diameter (mm.)	G/R Ratio
104	2	3	8.0	9	12	.75
62	2	3	10.0	7	17	.41
59	2	1	8.0	6	9	.66
598	2	1	9.0	5	11	.45
319	3	0	12.0	5	12	.42
798	2	1	7.0	5	9	.55

[1] Grade-5 is most tripsacoid

[2] Grade-5 shows strongest pubescence

Other Maize Remains

Richards' Caves. The twenty-two tassel fragments in this collection are not particularly significant in relation to teosinte introgression. The husk fragments (seventy-seven in number) are characteristic of Tripsacoid maize in that they are hispidulous (beset with minute epidermal bristles). Tripsacoid characteristics of fourteen culm fragments include a prominent, lignified rind and numerous vascular bundles. The shanks (thirty-six in number) are similar to the culm fragments in lignification. They are also rather uniform in length (5 to 7 cm.), although there is considerable variation in diameter (0.5 to 3.0 cm.) and in their having from six to ten nodes. This lot also yielded seven boluses, consisting of wadded and sometimes chewed grass leaves, probably from maize or its relatives.

Tonto. There are thirty tassel fragments, twenty-seven husks and fifty-two shanks from this site. These are not morphologically unusual or different from those of modern maize. There are also two depauperate culms bearing small ears near the basal end; three carbonized cobs; and twenty-two boluses which are similar in character to those from Richards' Caves.

Discussion

The earliest reports of natural hybrids between maize and teosinte date back to the "Zea canina" of Watson (1891). Harshberger later reported (1896) the findings of Professor J. C. Segura, which indicated that these plants were maize-teosinte hybrids. This has been confirmed by examining the Watson specimens preserved in the Gray Herbarium. Today, natural hybridization between teosinte and maize occurs frequently in Guatemala and Mexico. Although Randolph (1955) considers such hybridizations to be rare, his conclusion is inconsistent with the literature, as well as with his own observations. For example, he reports (1955, p. 45) finding 45 F_1 and 3 F_2 teosinte-maize hybrids near the villages of Nojoyá and San Antonio Huixta in northwestern Guatemala. Also from this region, where teosinte is the dominant plant over thousands of acres, Kempton and Popenoe (1937, p. 211) found in a collection of seed "several spikes of unmistakable hybrids." These authors report further that the farmers in the Jutiapa region of Guatemala "appreciated that teosinte hybridizes with corn and most informants lose no time in explaining that this plant will become corn in three generations if seed from the hybrid plant is grown." From Santa Ana Huixta, Guatemala, spikes of F_1 hybrids of maize and teosinte were present in teosinte collected by F. W. McBryde for the Harvard Botanical Museum (Mangelsdorf, unpub.). Such hybrids

are more frequent in the Chalco region near Mexico City, where Mangelsdorf (1952) found that slightly more than one percent of the "maize" plants in a cultivated field were actually F_1 hybrids of maize and teosinte. Even the small colony of perennial teosinte in Jalisco, Mexico, is reported by Collins (1921) to have contained a plant resembling an F_2 segregate of a maize-teosinte hybrid. Weatherwax (1935) mentions that, although maize-teosinte hybrids are continually coming into existence, the parent species do not blend because the intermediate forms have no survival value. Nevertheless, reciprocal introgression does occur between these species to the extent that it does not become deleterious. The result is the development of new races of teosinte and new races of maize. For example, the teosintes of Mexico usually have the same plant characters as the race of maize with which they commonly grow, while the maize from the same region shows evidence of teosinte introgression (Collins, 1921, and others). In this connection, all of the more productive races of maize in Mexico show evidence of teosinte introgression, some of which has come directly from outcrossing to teosinte (Wellhausen *et al.*, 1952). This beneficial effect of teosinte introgression is recognized by certain natives in western Mexico, as is evident from their practice of interplanting *maizillo* (almost certainly teosinte) and maize for the purpose of improving the latter (Lumholtz, 1902).

Randolph also questions whether these hybridizations have led to any significant amount of teosinte introgression in modern maize. It may be that local introgression has little influence in any one generation, but occurring over the centuries, it is almost certain to have some effect. Furthermore, Randolph's view is inconsistent with the archaeological evidence. The oldest archaeological cobs from Mexico and southwestern United States have soft,

leathery glumes, while in the more recent levels in these areas there is a sudden influx of Tripsacoid cobs. Some of these closely resemble derivatives from maize-teosinte hybrids in having highly lignified, crateriform lower glumes which diverge at right angles from a highly lignified rachis, distichous arrangement of spikelets, and occasional single spikelets resulting from a partial or complete reduction of the second, or pedicellate spikelet (Mangelsdorf and Lister, 1956). This sudden appearance in maize of as many teosinte characters as one can get from hybrids of maize and teosinte cannot be explained as resulting from parallel or random mutation as Randolph claimed. In addition, the evidence of prehistoric maize-teosinte heterosis, as revealed by the present study, suggests how teosinte germplasm has been maintained during recent evolution in maize.

Conclusions from the extensive experimental work which has been done on the relation of teosinte to modern maize have a direct bearing on interpreting the archaeological material described in this paper. The nature of teosinte germplasm has been described by Mangelsdorf and Reeves (1939) as consisting of multiple factor segments distributed on several maize-like chromosomes, these segments having similar effects on the morphological characters which distinguish the ears of these species. It is also known that the various teosinte varieties themselves have both qualitative and quantitative differences in germplasm affecting the teosinte characters (Rogers, 1950). This teosinte germplasm may be involved in heterosis, for its effects on maize may be beneficial when heterozygous and deleterious when homozygous (Mangelsdorf, 1952). Furthermore, maize inbreds in Texas vary in their capacity to be improved by teosinte introgression, as demonstrated by Reeves (1950). This variability also occurs in Mexican maize, since races grown at

low altitudes generally benefit from teosinte introgression (as indicated by chromosome knob number), while those grown at high altitudes suffer from introgression (Wellhausen and Prywer, 1954).

In the archaeological material, the strongest correlations between the characters studied have been between teosinte introgression and cob length; but the two curves expressing this relationship in the Tonto and Richards' Caves material are different, at least in regard to the extension of the curve. For example, the relationship between cob length and introgression at Richards' Caves is described as parabolic curvilinear, while at Tonto it is reciprocal curvilinear. A parabolic curvilinear correlation suggests that more than one casual factor is involved; and, in light of the evidence from modern material, it is explicable in this case in terms of teosinte homozygosity and heterozygosity. That is, the short Tripsacoid cobs represent a product of homozygosity for teosinte germplasm, while the long Tripsacoid cobs are a result of maize-teosinte heterosis. The reciprocal curvilinear correlation between these factors in Tonto maize appears to correspond to the left half of the parabolic curve for Richards' Caves maize. After considering the experimental data on modern maize, the lack of this apparent heterosis in Tonto cobs might be accounted for in one or more of several ways, such as: 1) introgression from a different type of teosinte germplasm; 2) different residual inheritance from maize; and 3) a breeding restriction on the spread of introgression. The last possibility is suggested because of the significantly lower average level of introgression at Tonto.

This "heterotic effect" on length of the cobs from Richards' Caves appears to be reflected in the kernel-row numbers of non-fasciated cobs. In this case, the heterotic stimulation (right side of the parabolic curve) is not as

great and actually declines again in the highest row number class. These results are again explicable in terms of modern maize. Normally heterotic vigor tends to increase row numbers within certain limits. In the archaeological material, the highest row number class probably tends to be beyond the range of introgression. As might be expected, the lack of heterosis in length of Tonto cobs is repeated in regard to kernel-row number. That is, introgression has only a general effect in reducing row numbers.

A third factor distinguishing these collections lies in the relationship between cob diameter and introgression. Although these characters are independent at Richards' Caves, diameters increase significantly with introgression in Tonto cobs. Thus, the more Tripsacoid Tonto cobs have greater diameters, lower row numbers and shorter ears. The first two of these characters suggest introgression from the indurated Northern Flints, but the third one seems to rule this out since these flints have long ears.

Fasciation and Row Number. Introgression tends to eliminate fasciation, or flattening of the rachis, by causing a slight reduction in row number. Nevertheless, in comparison to modern maize, fasciation is extremely frequent in the lower row numbers. In modern maize, fasciation is usually confined to row numbers well above the range of this prehistoric material. These facts suggest that teosinte introgression may so modify the expression of genes for fasciation that increases in row number are produced without the association of a flattened rachis.

Summary

1. Among archaeological cobs from Tonto and Richards' Caves in Arizona, there are many specimens which resemble, in appearance, those which occur in the F_2 and backcross generations of maize-teosinte hybrids.

2. Such cobs, because of their greater lignification, also resemble modern teosinte-contaminated maize in having a higher specific gravity and greater resistance to the action of sulphuric acid.

3. On the basis of induration or lignification of the cob, estimates were made of the amount of teosinte introgression in the archaeological specimens and correlations were calculated between these estimates and various morphological features of the cob.

4. The most significant correlations found were between teosinte introgression and cob length, but the curves expressing this relationship in the Tonto and Richards' Caves material are different.

The Richards' Caves material shows that teosinte introgression is associated with both longer and shorter cobs, indicating that maize-teosinte heterosis produces beneficial effects, while the homozygous expression of teosinte germplasm has detrimental effects. There is also an indication of the same sort of effects on kernel-row number, although no relation was found between diameter and introgression.

In the Tonto material there is no evidence of heterosis in regard to length and row number, although diameters do increase with introgression.

The different effects of introgression within and between these archaeological collections emphasize the complexity of the effects of teosinte introgression—sometimes beneficial, at other times detrimental or ineffective.

5. This material also has a bearing on the problem of the role of fasciation and teosinte introgression in the evolution of extreme polystichy of the ear. The results indicate that introgression modifies the expression of

genes for fasciation in such a way that they increase row numbers without causing a flattening of the rachis.

6. One of the few archaeological cobs known which duplicates the extreme form of modern tunicate maize, was found in these collections.

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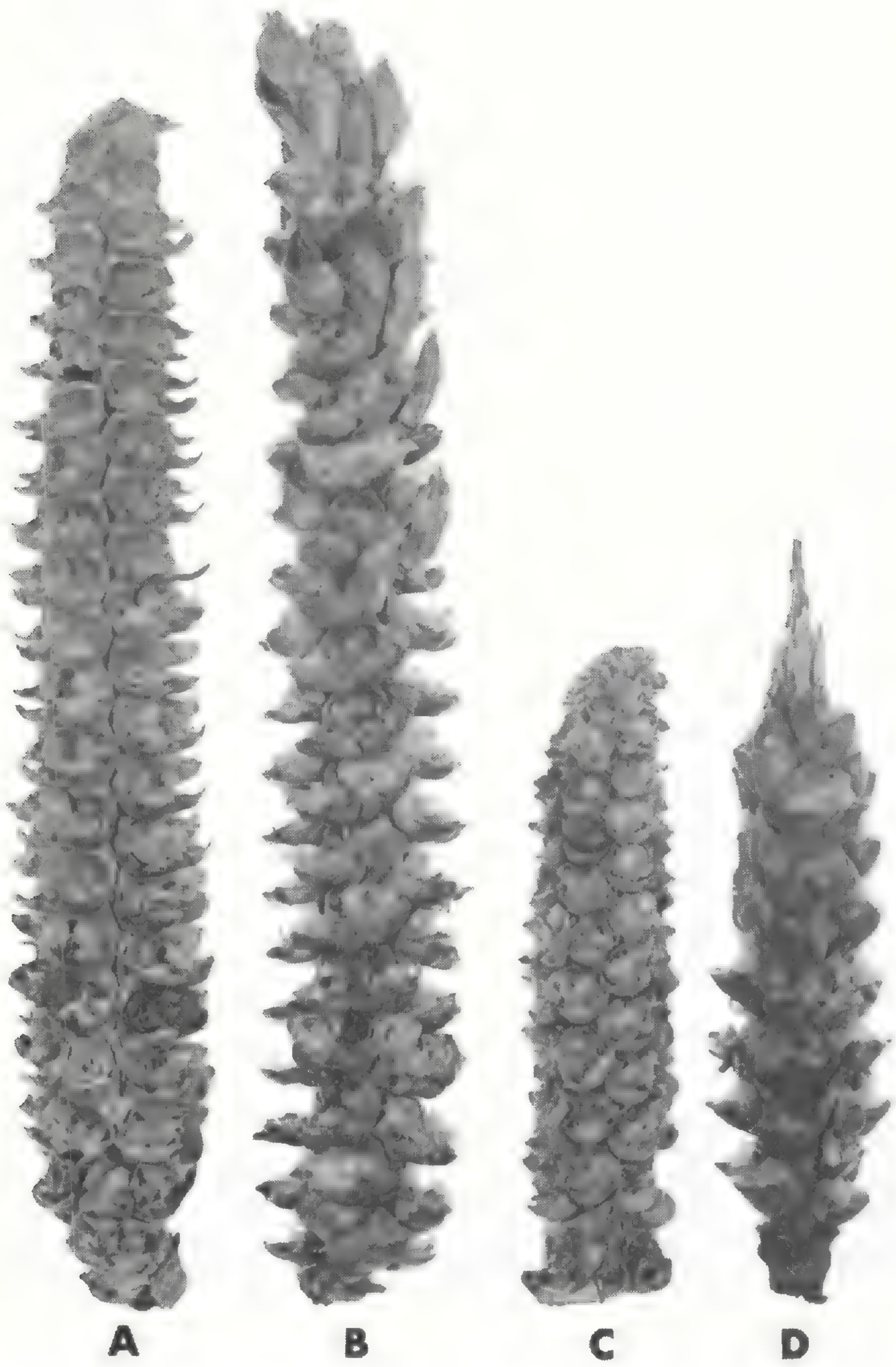
LIST OF ILLUSTRATIONS

EXPLANATION OF THE ILLUSTRATION

PLATE XXV. A comparison between archaeological cobs showing teosinte introgression in the Richards' Caves material (A, C) and their counterparts (B, D) produced experimentally from maize-teosinte hybrids. The modern specimens have been boiled in oil in order to produce the dark coloration characteristic of the prehistoric specimens. Note the similarity within pairs in regard to highly lignified crateriform lower glumes which diverge at right angles from a highly lignified rachis. Natural size.

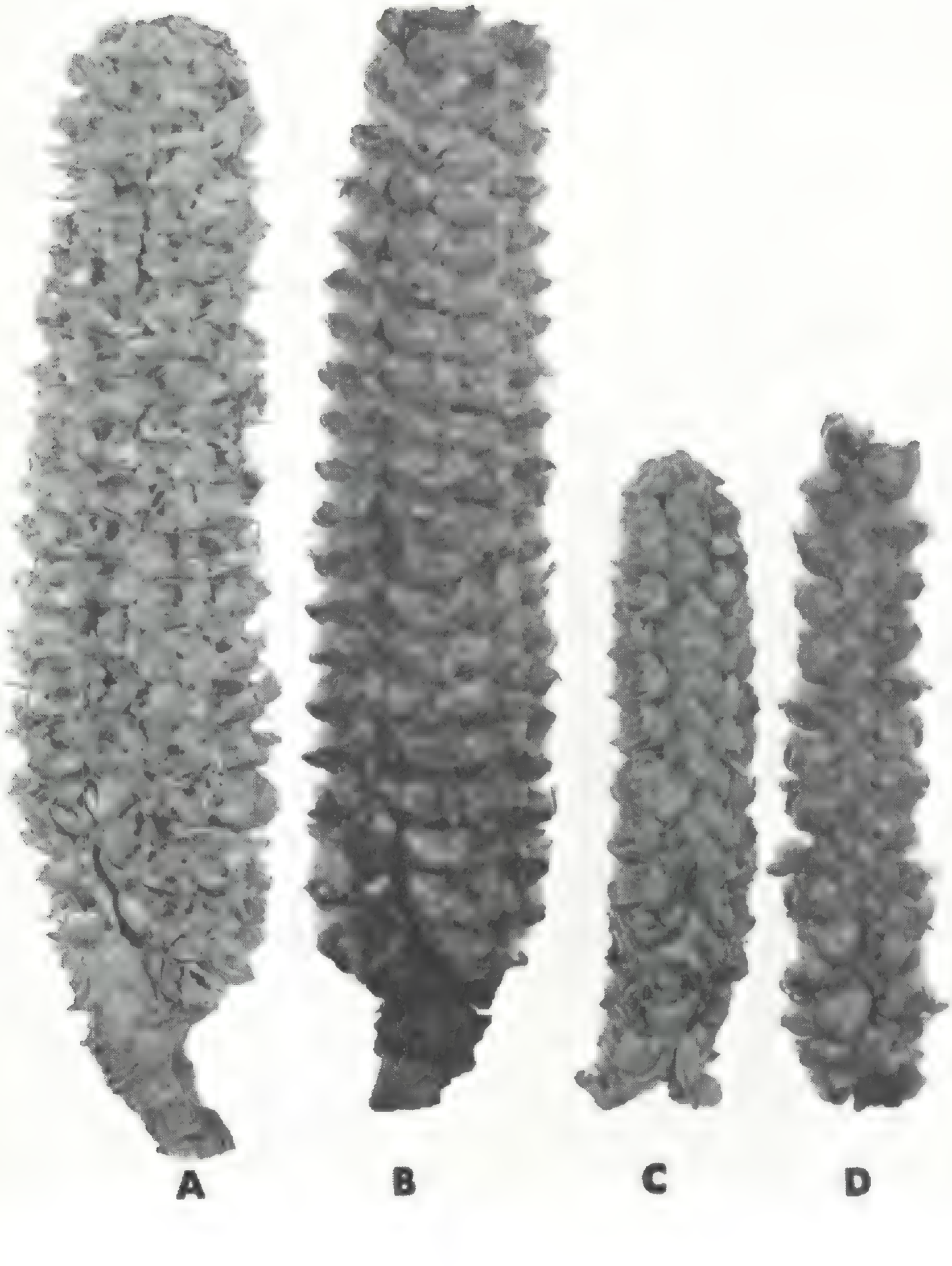
Plate XXV



EXPLANATION OF THE ILLUSTRATION

PLATE XXVI, as in previous plate. In cobs C and D note the distichous arrangement of spikelets. Natural size.

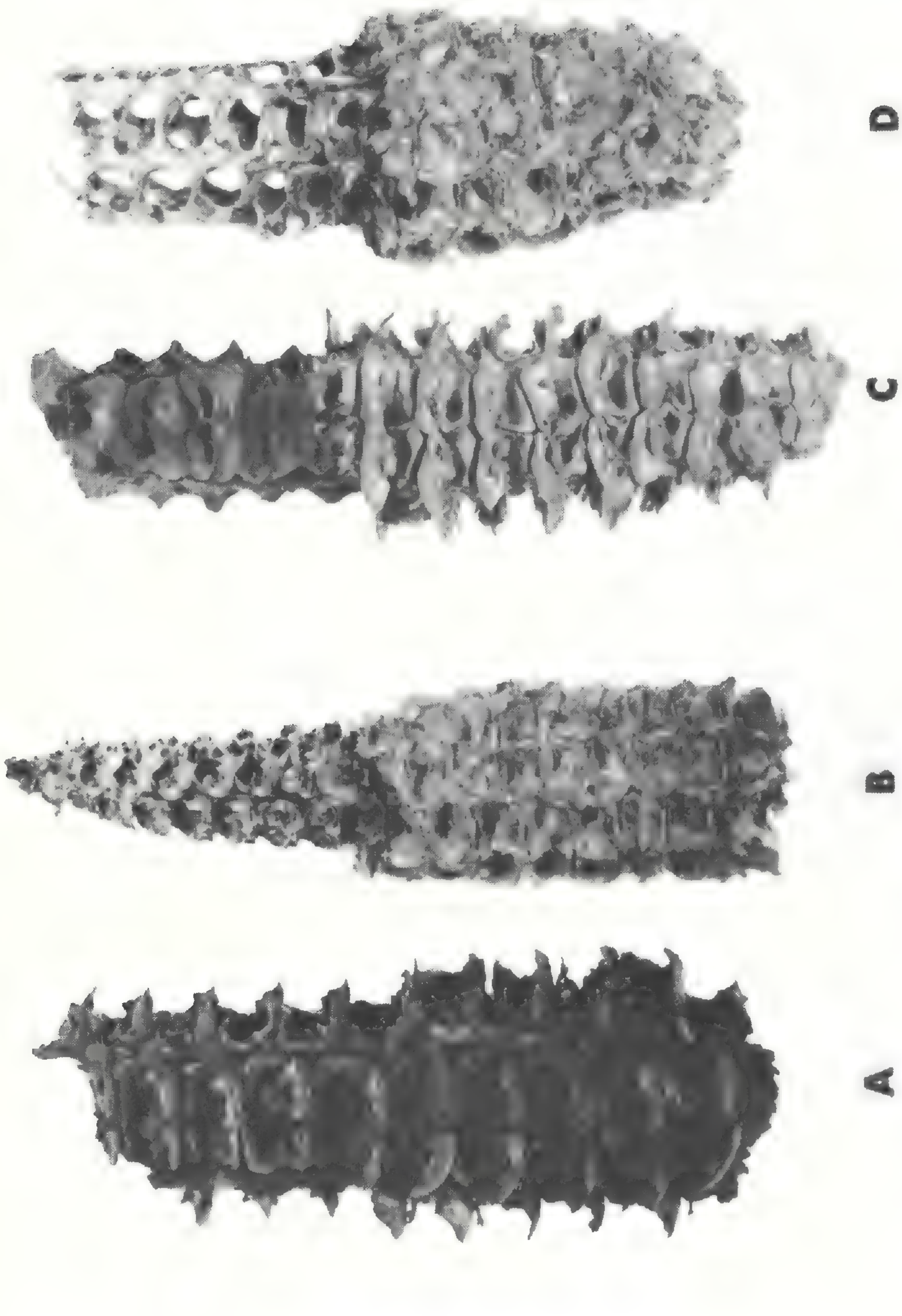
Plate XXVI



EXPLANATION OF THE ILLUSTRATION

PLATE XXVII. Tripsacoid (A, C) and non-Tripsacoid (B, D) cobs from Richards' Caves which have been subjected to ten hours (A, B) and twenty-four hours (C, D) of erosion by sulphuric acid. The treated portions are uppermost in the illustration. Note that in both treatments the Tripsacoid or lignified cobs are more resistant to the action of the acid. For example, the non-Tripsacoid cob (D) has disintegrated to a delicate framework of cupule margins. Natural size.

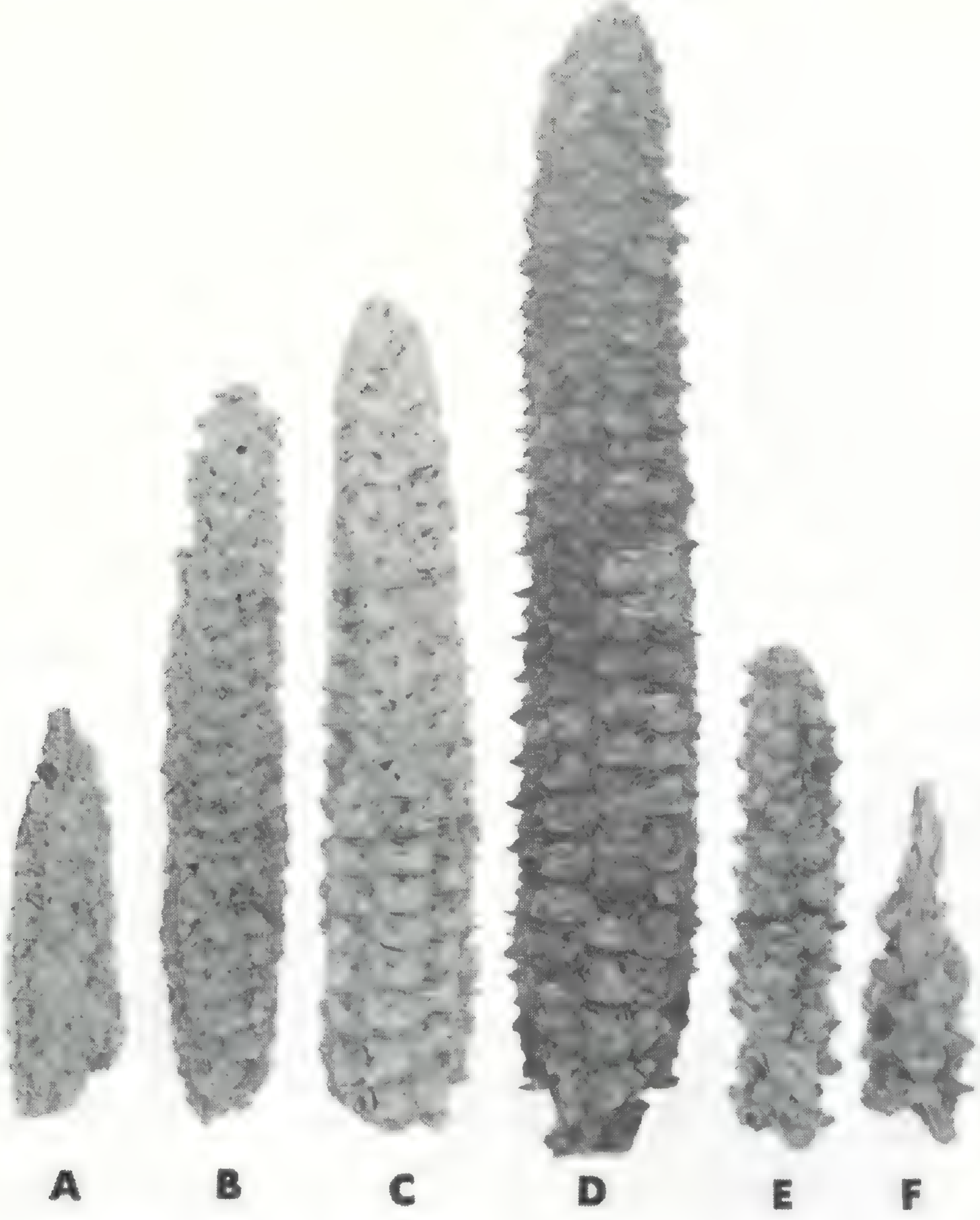
Plate XXVII



EXPLANATION OF THE ILLUSTRATION

PLATE XXVIII. Type archaeological specimens for the various grades of induration which were used to estimate teosinte introgression. A, grade-1; B, grade-2; C, grade-3; D, grade-4 long cob; E, grade-4 short cob; F, grade-5. The most Tripsacoid specimen (F) has a few single spikelets. Natural size.

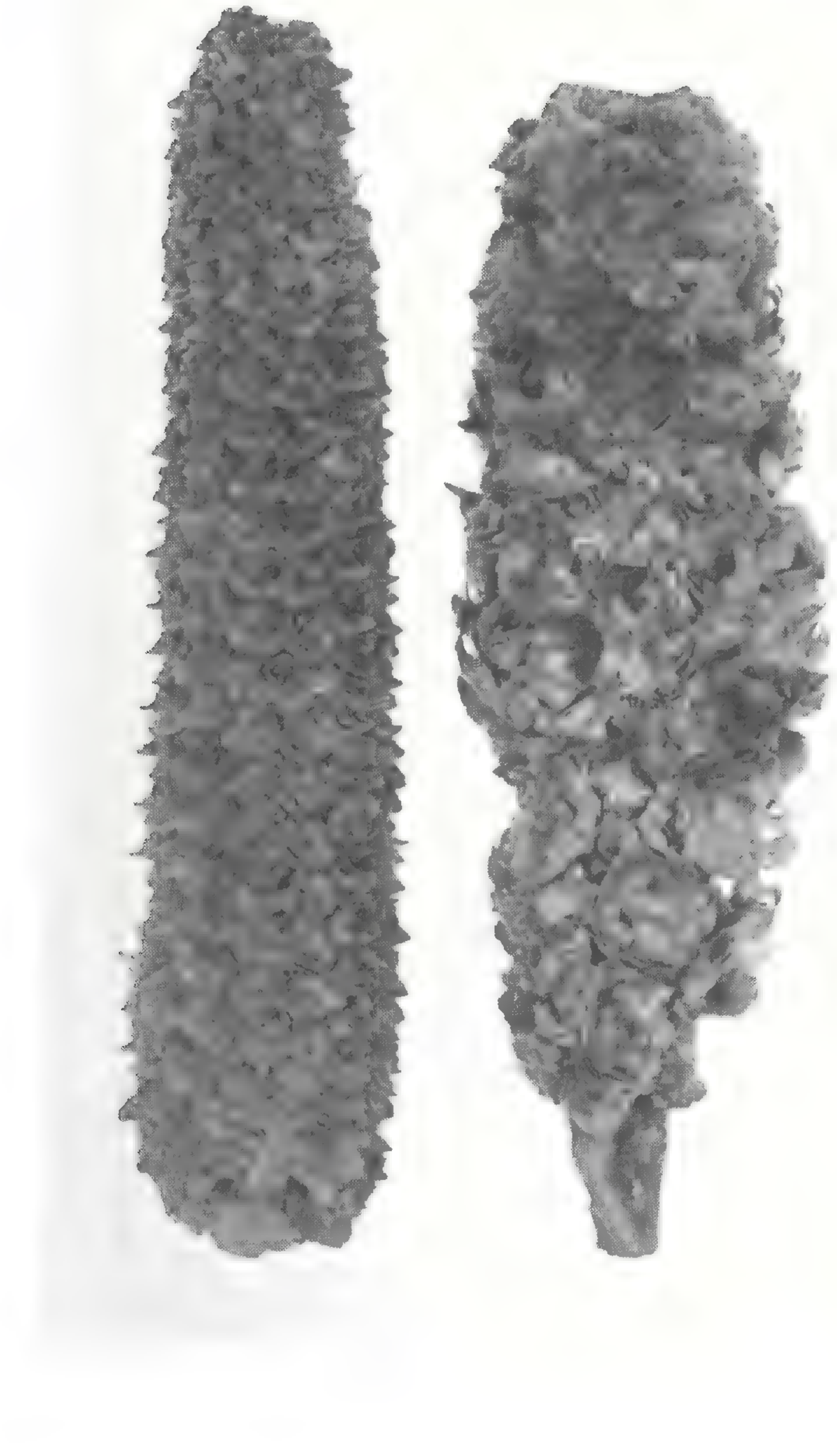
Plate XXVIII



EXPLANATION OF THE ILLUSTRATION

PLATE XXIX. Variation in glume length in cobs from Richards' Caves. The cob on the right is one of the few known archaeological specimens which duplicates the extreme form of modern pod maize. Natural size.

Plate XXIX



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ARCHAEOLOGICAL EVIDENCE ON THE DIFFUSION AND EVOLUTION OF MAIZE IN NORTHEASTERN MEXICO

BY

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DESCRIPTION OF THE SITE

IN 1945 and 1946, one of the authors (MacNeish) conducted an archaeological reconnaissance for the University of Chicago in the state of Tamaulipas in northeastern Mexico. Analysis of the survey material revealed that one part of this region, the northern Sierra de Tamaulipas, contained a series of sites which might be expected to yield a stratigraphic sequence of cultures ranging from relatively simple manifestations lacking pottery, agriculture or large settlements to more complex stages including agriculture, large settlements and a well-advanced technology (MacNeish, 1947). It was hoped that data obtained from such a sequence might shed light upon the problem of the development of civilization in Meso-America or that it would, at least, illustrate the transition from a hunting, food-gathering existence to a sedentary, agricultural mode of life. Accordingly, in 1948 and 1949 an expedition under the auspices of the Viking Fund (now the Wenner-Gren Foundation for Anthropological

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Research, Inc.) excavated a series of sites in the northern Sierra de Tamaulipas, a number of which were in rock shelters along the Canyon Diablo (MacNeish, 1950).

The northern Sierra de Tamaulipas is about 20 to 60 miles west of the Gulf of Mexico and from 60 to 100 miles northwest of Tampico. The mountains themselves are an eastern spur of the Sierra Madre and are relatively steep, though they rise only to about 3000 feet above sea level. They are composed of Cretaceous limestone which was uplifted at the end of the Mesozoic era.

Subsequent cutting by erosion has produced a series of steep-sided canyons, all of which eventually drain into the Soto la Marina River, which flows to the Gulf of Mexico. The climate is, generally speaking, dry, with rainfall (580 to 800 mm. per year) occurring mainly in the summer. The vegetation of the area is largely xerophytic and includes mesquite (*Prosopis juliflora* DC.), epozote (*Chenopodium ambrosioides* L.), palmito (probably a species of palm), yucca (*Yucca* spp.), zacaton (*Muehlenbergia* spp.), otate (*Arundinaria* spp.), prickly pear (*Opuntia* spp.), pita (*Fourcroea* or *Agave* spp.), and tall grasses.

Excavations of eight stratified sites (five of which were caves or rock shelters), as well as excavations or surface collections of about a hundred single-period archaeological assemblages in 1946, 1949 and 1954, revealed a long sequence of cultures. These have been termed (from late to early) as follows: Los Angeles Phase, La Salta Phase, Eslabones Phase, Laguna Phase, La Perra Phase, Nogales Phase, Lerma Phase, Almagre Phase, and Diablo Complex (MacNeish, 1950). The delineation of this cultural sequence and its significance will be dealt with in another publication. However, one site, La Perra Cave (Tm c 174), not only yielded stratified remains of three of the above-cited archaeological phases (Laguna, La

Perra and Lerma), but it also contained sequential botanical remains, some of which are relevant to the problem of the early use and evolutionary development of maize. As an introduction to the study of the specimens of maize from this site, consideration of the location, geography, excavation, stratigraphy and cultural sequences of the La Perra Cave is here presented.

This rock shelter was discovered on a brief survey of the Canyon Diablo in March 1949, under the guidance of Pedro Lerma of Los Angeles, Tamaulipas. It is about 18 miles northeast of the town of Los Angeles, about one-quarter mile north of the point where La Perra Canyon enters the Canyon Diablo. The cave is on the steep west side of the valley. It is situated more than 150 feet above the arroyo bed in the middle of a vine and shrub-covered, 100-foot-high cliff, at a point about 60 feet above the base. At the foot of the cliff is a talus slope covered with dense vegetation. The cave is not readily accessible, but can be approached by ascending a stream bed 400 feet north of it until a ledge at the level of the cave is reached. From here, one proceeds, preferably on hands and knees, southward along this ledge to the shelter. It is also possible to come down to the cavern from the plateau above, but, unfortunately, this approach was not discovered until after the excavations were completed.

The cave itself is situated in thinly-bedded Cretaceous limestone. It is about 23 feet deep, 40 feet wide at the mouth, 48 feet wide at 15 feet back from the mouth, and reaches a maximum height of about 15 feet. The floor of the cave slopes gently downward from the back wall to about eight feet from the mouth, where it dips very sharply.

No water is at present available during the dry season for a distance of 15 miles from the cave, but during prehistoric times there may have been water seepage from

the lower cliff wall or in the canyon itself. During a more humid period, the plateau above the cave or the low, wide terrace lying to the east across the Canyon Diablo bed may have been amenable to agriculture.

A test excavation made in Tm c 174 in February 1949, showed distinct zones and a few artifacts. A later test excavation turned up very few additional artifacts and the site was about to be abandoned when three maize cobs wrapped in maguey string, and a fragment of *petate* (woven fiber mat) were found. After this discovery, the entire cave was excavated, following the conventional method of digging in five-foot squares.

The stratigraphy of the cave comprised five zones. The uppermost, zone A, was made up of loose rock fill underlaid by ash and a layer of refuse composed in part of well-mixed vegetal material. The zone varied in thickness from four to 14 inches in different parts of the cave.

Underlying zone A was a stratum composed of gray refuse and lenses of ash and vegetal material separated from each other by soil. This was called zone B. It varied in depth in different parts of the cave and appeared to comprise several different levels of occupation. In analyzing the vegetal remains, a distinction was made between High B and Low B.

Zone C was a sterile layer composed of small flakes of rock and fine silt formed by the weathering of the surrounding limestone under relatively dry climatic conditions.

Zone D was a dark gray, almost black, cultural stratum, interspersed with layers of rock, covering only part of the cave floor and usually about a foot thick. Occasionally under zone D there was a thin layer of yellow silt, devoid of human remains, which is called zone E. In most of the cave, zone D lay directly on the limestone floor.

The earliest cultural remains come from zone D and are considered to belong to the Lerma Phase. At present, these cannot be accurately dated. The presence of thin fragments of deer bones, numerous large, double-pointed, thick projectile points and a wide variety of skin-scraping, chopping and cutting tools suggest that the subsistence of the first occupants of La Perra Cave was based largely on hunting.

The second complex of artifacts, from zone B, are considered to belong to the La Perra Phase. Other components of this phase were exhumed in Nogales Cave, 12 miles down the canyon from La Perra Cave, and in Cueva Humada in the southern Sierra de Tamaulipas. Altogether five sites belonging to this phase were found during the reconnaissance. The La Perra Phase appears to be related to a series of archaeological manifestations which range spatially from southern Texas to San Luis Potosi, Mexico. One of these from Falcon Dam in Texas, has been dated as 4650 years old, another from Tamaulipas as 3945 years old.

Vegetal remains from the lower part of zone B have been dated by radiocarbon determination at 4445 ± 180 years ago (Libby 1952).

An abundance of preserved remains (2504 specimens) of food plants, of which only a small number represent cultivated species, and the presence of stone mortars in zone B, suggest the extensive gathering of wild food plants. Fragments of animal bones, as well as projectile points and yucca fibers tied to form slip loops, indicate some dependence on the hunting and snaring of animals. A few specimens of squash (*Cucurbita Pepo*) and of maize cobs and husks suggest an incipient agriculture.

The final occupation of the cave, represented by zone A, is poor in artifacts. However, the presence of sherds, a figurine, point fragments and ovoid blades, showed the

occupation to be a component of the Laguna Phase which is well represented in the hill-top ruins that occur throughout the Sierra de Tamaulipas. This phase has definite affinities with the El Prisco (II) period of the Tampico-Panuco region (the Huasteca), which in turn has been correlated by Ekholm (1944) with the Ticoman-Cuilcuilco horizon of the valley of Mexico and which is dated by radiocarbon determinations at about 2400 years ago (de Terra, 1951). Allowing for some lag in the Sierra de Tamaulipas, a date of 1800 to 2200 years ago for the Laguna Phase would seem to be a fair estimate.

The foodstuffs in zone A of La Perra Cave indicate that the Laguna people were primarily agriculturists, growing beans, manihot, cotton, gourds, squashes, and maize. The abundance of angle-backed *metates* and roller *manos* in the hill-top ruins tend to confirm this. Wild food plants were, however, still gathered — 1426 specimens were found. Stemmed, corner-notched and side-notched points, as well as 122 animal bones in zone A, show that hunting was still practiced.

In summary, the sequence represented by the archaeological remains, seems to comprise three cultures, the first a predominantly nomadic hunting culture with no agriculture; the second a semi-sedentary hunting and food-gathering culture practicing an incipient agriculture; and the third a sedentary food-growing culture with a relatively advanced technology. The remains of maize found in the cave are confined to the last two cultures.

Description of the Maize

The archaeological specimens of maize from La Perra Cave are of particular interest from four standpoints: 1. The oldest specimens may be quite old, *ca* 4450 years; 2. The earliest maize is associated with incipient agriculture and may represent a maize in the early stages

of domestication; 3. The specimens represent a well-defined evolutionary series in a race of maize which still exists in Mexico; 4. The earliest maize definitely has its affinities in the south and is of Mayan origin.

The specimens comprise 177 items, including 87 cobs and fragments of cobs large enough for detailed study; 31 small fragments of cobs; 56 husks; and three quids which appear to be chewed maize husks.

Classification of the Cobs

As a whole, the cobs represent the most uniform lot of prehistoric maize which we have studied. Of the 87 cobs, 78 can be said, without much question, to belong to a single race which is clearly related to the living Mexican race, Nal-Tel. This race has been described by Wellhausen *et al* (1952), who report that it is grown in a number of localities in the states of Yucatan and Campeche and, sporadically, in Guerrero, Oaxaca, and San Luis Potosi. Nal-Tel is regarded by these authors as one of the four ancient indigenous races of Mexico and, therefore, as relatively primitive when compared to other races of modern maize. Nal-Tel is believed to have been widely distributed in ancient times. It is one of the putative parents of a number of modern Mexican races of maize, including Zapalote Chico, Zapalote Grande, Bolita, and Vandeño. Ears of it are depicted on a specimen of pottery from Guatemala and on Zapotec funerary urns (Plates XXXV and XXXVI).

Nal-Tel is described by Wellhausen *et al* as a race of short, early-maturing plants almost lacking in pubescence. The ears are small, short, and taper slightly at both ends. The number of kernel rows is usually ten or twelve. The kernels are small, broader than long, rounded and flinty. The rachis is slender and the glumes are relatively long and prominent. The shank, or peduncle, on

which the ear is borne is slender. The rachis flap, which represents a lateral wing of the cupule, is prominent.

Late Nal-Tel: Of the 78 cobs recognized as belonging to the race Nal-Tel, only 18 are counterparts of the modern Nal-Tel of the Yucatan peninsula. These are designated as Late Nal-Tel. The cobs have the same shape and approximately the same size as cobs of the living race. A comparison of the two is made below:

Characteristics	*Modern*	*Archaeological*
Ear length (mm.)	79.0	85.5
Cob diameter (mm.)	19.2	21.2
Rachis diameter (mm.)	9.2	11.4
Row no.	10–12	10–12

Typical cobs of Late Nal-Tel are illustrated in Plate XXXII.

Early Nal-Tel: The remaining 60 cobs resembling Nal-Tel represent a more primitive form of this race. The cobs are shorter and more slender. The rachises are smaller in diameter and, perhaps as a consequence, the ears have a lower row number. The glumes are fleshy and, although not actually longer than those of Late Nal-Tel, are more prominent in relation to the slender rachis.

The Early Nal-Tel cobs were further divided into two types, A and B, the former being smaller and more slender than the latter. These differences may be due in part to environmental effects. However, since a separation has been made for purposes of study, the data on the two types are presented separately. Cobs of the two types are illustrated in Plates XXX and XXXI.

Dzit-Bacal: Six cobs in the collection are definitely of a distinct type which differs from Nal-Tel. These are long, straight and slender, with especially slender ra-

chises. The glumes are slightly indurated. These cobs appear to be related to a race, Dzit-Bacal, described by Wellhausen *et al*, which now occurs most commonly in Yucatan and Campeche, where it hybridizes freely with Nal-Tel.

Breve de Padilla: The remaining three cobs, all large, cannot be definitely assigned to any race described by Wellhausen *et al.* They seem, however, to be related to a modern race, recently found in Mexico, in the state of Tamaulipas, known as Breve de Padilla (Wellhausen, unpublished). Since the sample comprises only three cobs, this identification cannot be considered as final.

Relation of Cob Types to Archaeological Zones

The above classification, which is based upon both external and internal characteristics of the cobs, was made without any knowledge of the relative age of the specimens. When the cobs are also classified with respect to the archaeological zone in which they occurred, it is apparent that there is a correlation between type and zone (Table I). Cobs of Breve de Padilla and Dzit-Bacal occurred only in zone A, cobs resembling modern Nal-Tel only in zones A and AB (the latter probably a mixture of zones rather than a distinct entity). Cobs of both types of Early Nal-Tel were found in both zones and were the only type occurring in zone B.

There seems to be little doubt that agriculture in this locality began with an early type of Nal-Tel and that the occupation of the cave ended shortly after the introduction of Dzit-Bacal from the south. Whether the Late Nal-Tel found in zone A was also introduced from the south or is the product of the local hybridization of Early Nal-Tel and Dzit-Bacal, it is not possible to determine. It does seem reasonably certain, however, that there was

little change in Early Nal-Tel itself during the period represented by these remains. There is no significant change from zone to zone, either in the frequency of types A and B of Early Nal-Tel or in their characteristics. Certainly there is no evidence that this race was improved by selection, either natural or artificial, during

TABLE I. Classification of specimens of La Perra maize.

Specimens	Zone				
Cobs, Race or Type	A	AB	High B	Low B	Totals
Breve de Padilla	3				3
Dzit-Bacal	6				6
Late Nal-Tel	14	4			18
Early Nal-Tel Type B	17	6	2	11	36
Early Nal-Tel Type A	19	3	1	1	24
Total cobs	59	13	3	12	87
Fragments of cobs	24	5	2		31
Husks	22	31	3		56
Quids	2			1	3
Total maize specimens	107	49	8	13	177 *

* There are, in addition, three cobs loaned to the Museum of Anthropology, University of Michigan, which were not analyzed.

this period. Improvement did not come about until something new was introduced, from the south, or hybridization occurred in the area.

Late Nal-Tel, which first appears in zone AB, but which, since zone AB probably represents a mixture, may actually be confined to zone A, is definitely a different type of maize than Early Nal-Tel, as the data in Tables II and III show.

One of the important differences between these two types is in teosinte introgression. This almost invariably affects the texture of the lower glumes, causing them to become lignified and indurated. In Early Nal-Tel, of

TABLE II. Characteristics of the cobs of the races of La Perra maize.

	Zone				
Length Intact Cobs (mm.)	A	AB	High B	Low B	Averages
Breve de Padilla	134				134
Dzit-Bacal	117				117
Late Nal-Tel	85	88			86
Early Nal-Tel Type B	62	57		52	60
Early Nal-Tel Type A	48	49	44		48
Averages	66	65	44	52	
Diameter Cob (mm.)					
Breve de Padilla	26.0				26.0
Dzit-Bacal	19.7				19.7
Late Nal-Tel	21.4	21.7			21.5
Early Nal-Tel Type B	18.1	18.3	17.6	19.0	18.4
Early Nal-Tel Type A	15.2	16.0	10.0	18.4	15.2
Averages	18.4	18.9	15.0	19.0	
Diameter Rachis (mm.)					
Breve de Padilla	16.3				16.3
Dzit-Bacal	11.1				11.1
Late Nal-Tel	13.2	12.7			13.1
Early Nal-Tel Type B	10.4	10.2	10.1	11.3	10.7
Early Nal-Tel Type A	8.4	8.5	6.5	8.3	8.3
Averages	10.8	10.6	8.9	11.1	
Cob/Rachis Index					
Breve de Padilla	1.59				1.59
Dzit-Bacal	1.78				1.78
Late Nal-Tel	1.62	1.72			1.64
Early Nal-Tel Type B	1.75	1.81	1.74	1.73	1.75
Early Nal Tel Type A	1.89	1.88	1.54	2.22	1.89
Averages	1.76	1.80	1.68	1.77	
No. Rows Grain					
Breve de Padilla	12.0				12.0
Dzit-Bacal	9.3				9.3
Late Nal-Tel	10.9	11.0			10.9
Early Nal-Tel Type B	10.0	10.0	10.0	10.5	10.2
Early Nal-Tel Type A	8.8	8.7	10.0	10.0	8.9
Averages	9.9	10.0	10.0	10.5	

59 cobs scored, only seven appeared to have indurated glumes; and all of these, on further study, proved to be slightly charred, and, as a consequence, hardened. Of 17 cobs of Late Nal-Tel, nine had distinctly lignified glumes.

Another characteristic of teosinte-contaminated maize is the manner in which the floral structures separate from the rachis. In pod corn and in races of "pure" maize, the breakage occurs below the lower glume, leaving the rachis completely exposed. In maize strongly contaminated with teosinte, the lower glumes are, as in teosinte itself, indurated like the rachis and tend to remain firmly attached to it, while the upper glume with the lemmas and paleas are easily separated from the cob. Such cobs, which have lost the upper glumes, lemmas and paleas, but have retained the indurated lower glumes, have the appearance of coarse rasps with stiff teeth projecting from the surface approximately at right angles.

Most of the ears of Late Nal-Tel, as well as those of Dzit-Bacal, show to a discernible degree this type of disarticulation, which is characteristic of teosinte-contaminated maize. The majority of the cobs of Early Nal-Tel show the disarticulation characteristic of "pure" maize.

It is not possible, from the limited number of cobs available, to draw final and complete conclusions regarding the sequence of maize types grown by the La Perra cultivators. The data, so far as they go, are consistent with the hypothesis that the early tenants of the cave grew only one race of maize, Early Nal-Tel, a "pure" maize, uncontaminated by teosinte, and which had its origin in the south. Later occupants of the cave grew three new types, Late Nal-Tel, Dzit-Bacal, and Breve de Padilla, two of which have affinities with the maize of the Maya region and also show evidence of teosinte introgression.

The data are also consistent with those from other

TABLE III. Internal characteristics of the cobs of the races of La Perra maize.

	Zone								Totals	
Lower Glumes: Fleshy vs Horny	A		AB		High B		Low B			
Breve de Padilla	1	2							1	2
Dzit-Bacal	1	5							1	5
Late Nal-Tel	4	9	4	0					8	9
Early Nal-Tel Type B	11	5	5	1	2	0	10	1	28	7
Early Nal Tel Type A	19	0	3	0	1	0	1	0	24	0
Totals	36	21	12	1	3	0	11	1	62	23
Upper Glumes: Glabrous vs Hairy										
Breve de Padilla	3	0							3	0
Dzit-Bacal	4	2							4	2
Late Nal-Tel	4	9	3	1					7	10
Early Nal-Tel Type B	12	4	5	1	2	0	10	1	29	6
Early Nal-Tel Type A	15	4	3	0	1	0	1	0	20	4
Totals	38	19	11	2	3	0	11	1	63	22
Disarticulation of Glumes: Maize type vs Tripsacoid										
Breve de Padilla	1	2							1	2
Dzit-Bacal	1	5							1	5
Late Nal-Tel	1	12	3	1					4	13
Early Nal-Tel Type B	10	6	5	1	2	0	10	1	27	8
Early Nal-Tel Type A	17	2	3	0	1	0	0	1	21	3
Totals	30	27	11	2	3	0	10	2	54	31
Rachis Flap: Weak vs Prominent										
Breve de Padilla	2	1							2	1
Dzit-Bacal	0	6							0	6
Late Nal-Tel	2	11	1	3					3	14
Early Nal-Tel Type B	6	10	2	4	1	1	3	8	12	23
Early Nal-Tel Type A	4	15	2	1	0	1	1	0	7	17
Totals	14	43	5	8	1	2	4	8	24	61

sites. Galinat *et al* (1956) found definite evidence of teosinte introgression in the archaeological maize at Richards' Caves and Tonto Cave in Arizona. Their review of the literature showed that Tripsacoid cobs also occurred in Bat Cave and Tularosa Cave in New Mexico and in the Hueco Mountain Caves of western Texas. Preliminary studies of archaeological material collected by Robert Lister from several caves in Chihuahua in northwestern Mexico indicate that teosinte introgression has occurred in that region also.

Since teosinte is not known to occur in Tamaulipas at the present time, there is a question regarding the origin of the teosinte introgression in Late Nal-Tel and Dzit-Bacal of La Perra Cave. It is probable that this occurred in southern Mexico. Wellhausen *et al* regard Dzit-Bacal as a subrace of Olotillo, which is highly Tripsacoid and they report that modern Nal-Tel is slightly Tripsacoid, presumably as a consequence of hybridization with Dzit-Bacal.

An Extreme Form of Early Nal-Tel

As important as the range of variation in these specimens, or the average value for any one characteristic, are the exceptional cobs. One of these in particular, cob 12705, is somewhat different from any maize cob which we have previously examined. It is eight-rowed and has a very slender rachis which is approximately square in cross section. The cupules are compressed, deep, and are lined with a profuse covering of stiff hairs. The glumes are long, fleshy, and completely glabrous. They have the aspect of normal glumes of a wild grass. It is not likely that they completely enclosed the kernels, but they may have surrounded all parts of the kernels except the upper surfaces. The cupules, which in ordinary maize are tightly compressed on the rachis, with their lateral wings

called "rachis flaps," sometimes protruding from the surface, are in this specimen loosely spaced with the result that the rachis flap is extremely prominent. The phytomers of the rachis are loosely joined. The general structure is one which, if its characteristics were slightly exaggerated, would furnish a mechanism for the breakage of the ear and the dispersal of the seeds. The structure of this cob and its parts is shown in Plate XXXIV.

This is the first archaeological maize approaching a type capable of self-sowing which we have encountered. Although there is little possibility that it is wild maize, it may not be too far removed from it. And yet it has no characteristics in which it differs completely from the remaining specimens in this collection. It merely exhibits the characteristics of Early Nal-Tel in somewhat accentuated form.

Is Early Nal-Tel a Pod Corn?

Mangelsdorf and Reeves (1939), following earlier students of maize, postulated that primitive maize was both a pop corn and a pod corn. The cobs of Early Nal-Tel bear out the first assumption. Whether they support the second may be largely a matter of definition. Certainly the primitive Nal-Tel with its relatively thick, fleshy glumes is different from any tunicate maize of this type known today. Mangelsdorf (1948) has shown, however, that there are several intermediate alleles at the *Tu-tu* locus on chromosome 4 and it may well be that Nal-Tel carries one of these. Unfortunately, it is impossible to test the genotype of Early Nal-Tel to determine which of the alleles at the *Tu-tu* locus is responsible for its prominent glumes. However, another Mexican pop corn, Chapalote, closely related to Nal-Tel, has relatively prominent glumes similar to those of Nal-Tel and genetic tests indicate that these are governed by an intermediate

allele in this series. Crosses of Chapalote with sugary endosperm, *su*, on the fourth chromosome, show linkage between *Su* and prominent glumes (Mangelsdorf, 1953). The resemblance of Nal-Tel and Chapalote, considered with the evidence on linkage of long glumes and starchy endosperm in Chapalote, would suggest that the prominent glumes of Nal-Tel involve one of the intermediate alleles in the *Tu-tu* series.

The Husks

The collection contained 56 well-preserved specimens of husks, some representing only a single sheath, others the entire husk covering still attached to the shank.

Flag Leaves and Ligules: Husks, which in modern maize surround and usually tightly enclose the ear, are modified leaf sheaths, sometimes with reduced blades, called "flag leaves," attached and a recognizable ligule at the point of attachment. Of nine completely intact husks in this collection, not one had either a "flag leaf" or a ligule.

Relative Length: The husks are rather uniform in length. Twenty-one specimens are intact, or almost so, with respect to length, and these are much longer than the cobs occurring in the same zones. The length of intact husks and cobs is compared in Table IV. The husks, which average 140 mm. in length, are 2.3 times as long as the corresponding cobs which average 60 mm. In making these comparisons, only cobs of Early and modern Nal-Tel and only husks with definite parallel venation have been included. Specimens from zone B indicate that these types of ears and husks are associated.

Mangelsdorf and Smith (1949), studying archaeological remains of husks from Bat Cave, concluded that the

husks were considerably longer than the ears which they subtended and that, instead of tightly enclosing the ears, they constituted an open involucre at the base of the ear. The La Perra specimens tend to support and to amplify these conclusions.

A single specimen of a young ear shoot, partly chewed, shows clearly that at the time of emergence of the silks the pistillate spike is tightly enclosed in the husks.

TABLE IV. Length of intact shucks of La Perra maize compared with length of intact cobs of Early and Late Nal-Tel.

Specimens	Zone			Total or Average
	A	AB	B	
No. shucks	4	15	2	21
Length (mm.)	135	142	135	140
No. cobs	21	3	2	26
Length (mm.)	61	68	48	60

Therefore, if the husks open to form an involucre, this must take place later as the pistillate spike matures. In a recent trip to Mexico, the senior author made a special effort to determine whether the flaring open of the husks at maturity is a characteristic of modern Nal-Tel and he discovered that many of the plants of this race do have this feature. It may well be, therefore, that the spreading of husks at maturity is a primitive characteristic which, in wild corn, was an important step in the mechanism of seed dispersal.

Venation: The husks are also quite uniform with respect to their venation. With few exceptions, all of them have distinct parallel venation. In modern maize, where the husks are often stretched tightly around the mature ear, the aspect of parallel venation is partly lost as the anastamosing venation between the principal veins be-

comes more prominent. In more primitive maize, parallel venation is distinct, even in the inner husks, and causes striations on the surface of the kernels (Mangelsdorf and Smith, 1949).

Pubescence: To the naked eye, and to the touch, all but three of these specimens are glabrous, the three exceptions being slightly hispidulous. When examined under the microscope, however, all of the husks proved to have very short hairs, either on the inner or outer surface, or both. Not one was completely lacking in hairs. There is no evidence that variation in this feature is associated with archaeological zones.

The fact that the husks, which are modified leaf sheaths, and the glumes, which are modified leaves, are predominantly glabrous (macroscopically) might indicate that the plants on which these specimens were borne were also glabrous. Wellhausen *et al* report that plants of modern Nal-Tel have little pubescence.

The Shanks

The cobs themselves with their slender rachises would indicate that the ears of La Perra maize were borne on slender shanks or peduncles. Husks with shanks still attached bear out this indication. Twelve specimens have an average diameter of 6.7 mm. at the point at which the ear was removed. This compares with a shank diameter of 7.1 mm. for modern Nal-Tel reported by Wellhausen *et al.*

These same specimens are useful in showing how the husks are spaced on the shank. Each husk arises from a node on the shank which is itself a branch of the main stalk. In many modern varieties of maize, the internodes on the shank are long, and the entire husk-bearing space, which is essentially equivalent to the length of the shank,

may in some cases be as long or longer than the ear itself. In the La Perra maize, the internodes of the shank are extremely short and the entire shank is correspondingly so. In the twelve specimens mentioned above, the length of the shank varies from 6.0 mm. to 33.0 mm. and the average is 8.6 mm.

Among modern varieties of maize, ears with short, slender shanks are usually borne at a high position on the culm. On any given plant, there is usually a strong inverse correlation between the relative height of ear and length of shank. Galinat (1954) found that the shank lengths for twelve ears borne on a single stalk of Argentine pop corn varied from 19 mm. in the uppermost ear to 134 mm. in the lowermost. The short shanks of the La Perra maize, therefore, might suggest that the ears of this maize were borne high on the stalk. The data of Wellhausen *et al*, as well as the internode patterns illustrated in their Plate VIII, tend to support this suggestion. They show that plants of modern Nal-Tel have, on the average, 4.3 leaves above the ear and that the internodes above the ear are relatively short. This is also true of some modern pop corn varieties, and it may suggest that a high position of the ear on the culm is a primitive character. If so, the early maize of La Perra Cave may have had this character, as it clearly had others, in accentuated form. Indeed, it is possible that primitive maize may have borne its ear immediately below the tassel (Galinat, 1954). In some of our cultures of tunicate and half-tunicate maize, we have encountered a number of plants in which small ears were borne at the first node below the tassel. The husks on such ears are few in number and lack flag leaves and ligules, although ears borne lower on the same stalks may have prominent flag leaves and conspicuous ligules. These sub-tassel ears are enclosed by the husks at pollinating time and for several weeks

thereafter; but eventually they spread open, exposing the ear.

Primitive Nal-Tel Reconstructed

In those characteristics which can be studied in archaeological remains, Early Nal-Tel proves to be modern Nal-Tel with some of its characteristics in accentuated form. If it may be assumed that this is also true for other features, it is possible by extrapolation to reconstruct this precursor of the modern, though still somewhat primitive race.

So far as the characteristics of the ear are concerned, little extrapolation is needed. Primitive Nal-Tel ears were short, rather stubby, eight-rowed, with small, short, broad, flinty kernels. Such ears are beautifully depicted in one of the funerary urns from Oaxaca described and illustrated by Caso and Bernal, 1952, which is reproduced by permission of the authors in Plate XXXVI. Unfortunately, the exact dimensions of the urn are not available. However, if it has approximately the same dimensions as other urns of this type, the ears represented on it are about 47 mm. long. This figure corresponds closely to the average length, 48 mm., of cobs of Early Nal-Tel, Type A.

The ears were surrounded, but at maturity apparently not completely enclosed, by husks. The short, slender shanks indicate that the ears were borne at one of the higher nodes.

For other characteristics, we turn to the data of Wellhausen *et al* (Tables 13–17) which show that the plants of modern Nal-Tel are the shortest of any living race in Mexico (averaging four feet) and bear the fewest leaves (averaging twelve). The leaves are among the shortest and, in proportion to length, the broadest. The internodes above the ear are shorter and fewer than those of

any other race. The shank is short and slender. The condensation index, 1.0, is the lowest of any Mexican race. Nal-Tel is early in maturity, highly susceptible to rust, low in pilosity and has a light sheath color.

When we reconstruct a primitive Nal-Tel in which a number of these features occur in accentuated form, we find that a plant resembling it has already been depicted for us in one of the ancient Mexican codices (see Wellhausen *et al*, 1952, Fig. 3). Botanists who are familiar with this illustration have always regarded it as highly stylized. In the light of the characteristics of Nal-Tel, there is reason to suspect that the maize plant depicted is not completely stylized, but that it is accurate in illustrating a maize with short stalks, relatively few short, wide leaves, and bearing at one of the upper nodes a short ear incompletely enclosed in husks.

Although Early Nal-Tel differs from modern Nal-Tel in a number of characteristics, the differences are not great and are more a matter of degree than of kind. There has actually been very little evolution in this race of maize in a period of some 4500 years. This is in marked contrast to certain other Mexican races in which evolution has been rapid and even spectacular.

Primitive Uses of Maize

How did the primitive La Perra farmers use maize? It is reasonable to suppose that, just as there has been evolution in the maize plant, so has there also been evolution in methods of utilizing it. It may also be supposed that this evolution has been from the more simple to the more complex. The archaeological remains suggest several uses.

Chewing Young Ears: The simplest and easiest method was to chew the young ears, husks and all, soon after

pollination. There are, among the specimens, two thoroughly chewed quids which do not seem to be quids of yucca or maguey, and whose fibers are similar to those of maize husks. In addition, there is one specimen, an unpollinated or recently pollinated ear, enclosed in husks, in which chewing was begun but not completed.

There is no doubt that the young maize ear is an attractive food morsel. After seeing these prehistoric quids, we tried chewing young ears enclosed in husks and found them tender, succulent and sweet. No equipment of any kind is required in consuming maize in this way. The method is, of course, quite wasteful from the standpoint of efficient utilization of the maize plant and, if universally practiced, would lead to the plant's extinction; but it is a quick and simple way of obtaining a little sugar.

Green Corn: A second use of primitive maize is as green corn. There are several specimens in which the lower part of the kernel still remains within the glumes, the upper part having been removed, either by chewing or with a coarse blade. Roasted ears of green corn, *elotes*, are still a popular delicacy in Mexico, as apparently they were in prehistoric times.

Popped or Parched Corn: Other common uses of maize are by popping or parching. We have found no actual remains of popped maize among the specimens from La Perra Cave, but many of the cobs are slightly scorched or charred, showing that they have been exposed to heat. To pop maize, the only equipment needed is a bed of hot coals and a green stick sharply pointed at one end and pushed into the base of the ear. The ear is held over the coals and slowly rotated. We have simulated this procedure with modern pop corn, substituting an electric hot plate for glowing coals. The kernels explode while on the

ear and are easily picked off and eaten. The glumes are slightly charred during this process.

If maize kernels do not have the proper moisture content, they parch rather than pop when exposed to heat. Parched maize, although not as tender as popped maize, is much easier to chew or grind than unprocessed maize, especially of the pop corn or flint type. There is little doubt that at least some of the La Perra maize was consumed in parched form.

Grinding: On many of the cobs from La Perra Cave, the glumes are battered and broken as though the ears might have been forced across a rough surface or beaten with a stick. This would indicate a crude shelling operation and this, in turn, suggests the use of shelled grain. Since stone mortars were found in La Perra Cave, it seems quite likely that, in addition to the uses described above, maize was also ground. But what use might have been made of it after grinding, there is no way of determining. There is no evidence of baking and no remains of any kind of bread. Whether the maize growers of La Perra Cave had learned to make the *tortilla*, the ubiquitous maize bread of modern Mexico, must remain an unanswered question.

Summary

1. This paper describes archaeological specimens of maize obtained from a sequence of cultural remains in La Perra Cave in Tamaulipas, Mexico.

2. The earliest maize is dated on the basis of radio carbon determinations of associated vegetal remains at 4445 ± 180 years old. The most recent maize is estimated to be 1800–2200 years old.

3. The majority of the cobs are related to the modern Mexican race Nal-Tel which today is grown principally farther south in Yucatan and Campeche. The more recent prehistoric cobs of this race are quite similar to modern Nal-Tel, but the earlier cobs are smaller, more slender and have a lower average kernel-row number. The earlier specimens also have prominent glumes and probably represent a weak form of pod corn.

4. The remaining cobs are related to the living races of maize in Mexico, Dzit-Bacal, commonly grown in Yucatan and Campeche, and Breve de Patilla, commonly grown in Tamaulipas.

5. Specimens of husks and shanks show that Early Nal-Tel had short, slender shanks and relatively long husks, lacking ligules and flag leaves, which spread open at maturity.

6. In these characteristics in which they can be directly compared, Early Nal-Tel is an accentuated form of modern Nal-Tel. On the assumption that this is also true of other characteristics, the Nal-Tel of 4500 years ago is reconstructed and described.

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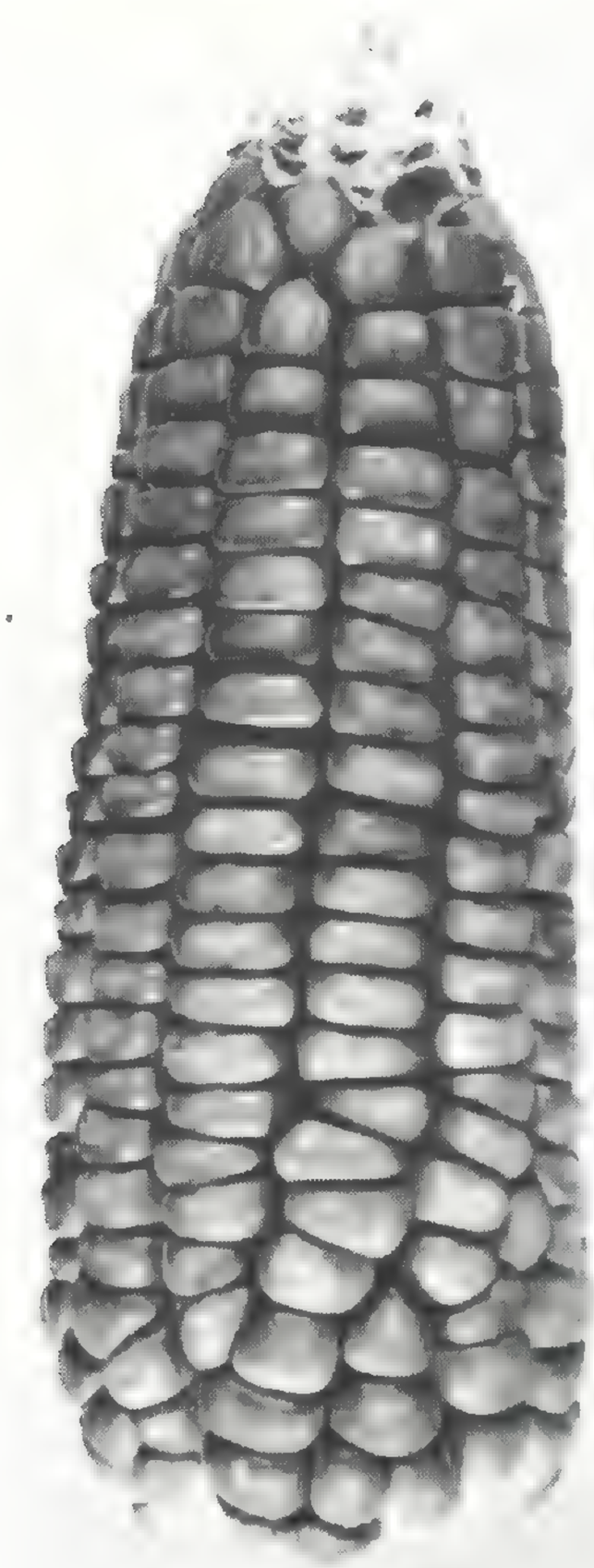
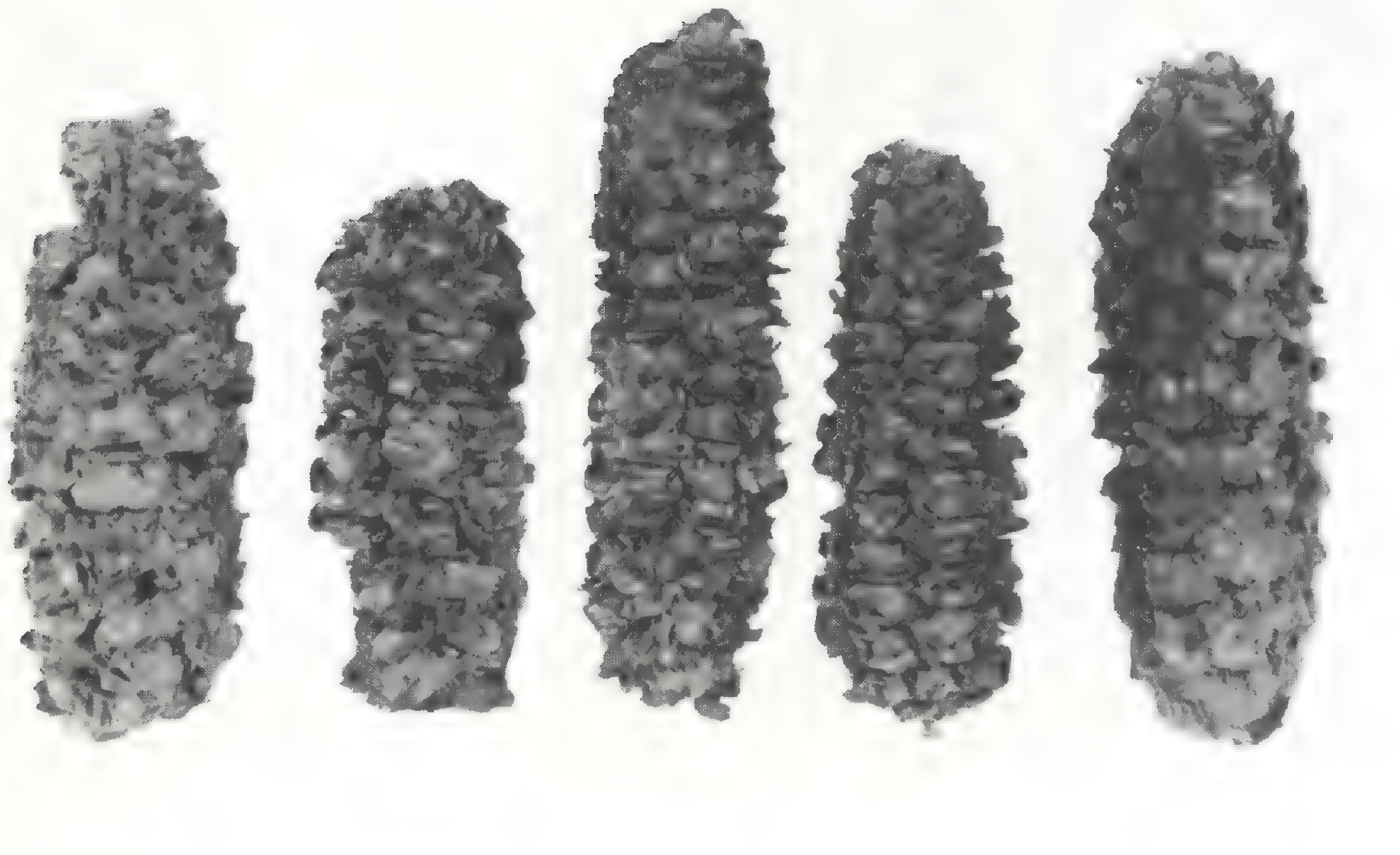
LIST OF ILLUSTRATIONS

EXPLANATION OF THE ILLUSTRATION

PLATE XXX. *Upper Figure.* Typical ear of modern Nal-Tel, a Mexican race of Mayan origin, today found principally in Yucatan and Campeche. Most of the maize of La Perra Cave appears to be related to this race. *Lower Figure.* Typical cobs of Early Nal-Tel, Type A. They resemble modern Nal-Tel in shape (tapering at both ends) and in internal characteristics, but are smaller and have a lower row number. Both figures natural size.

Plate XXX

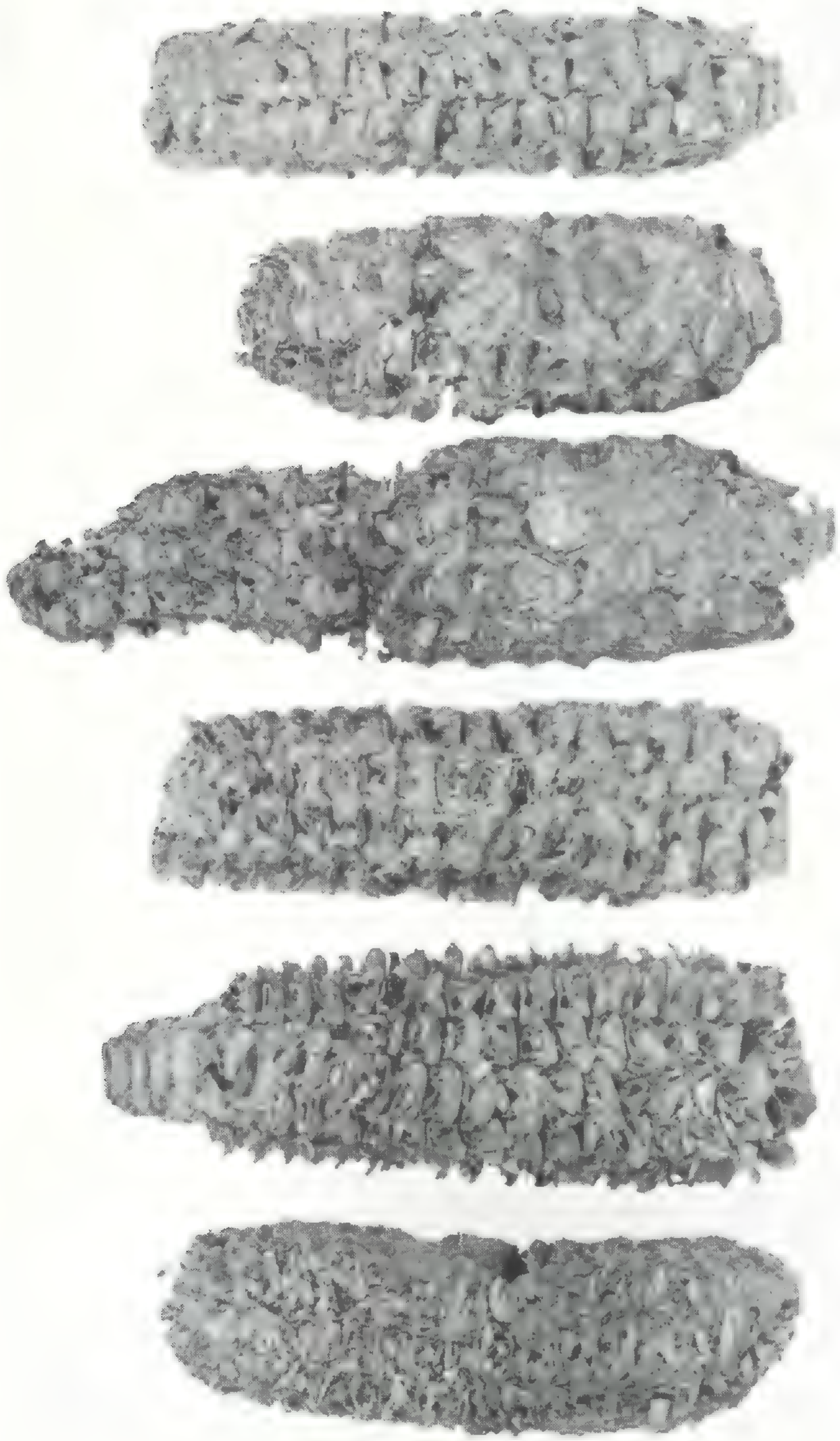




EXPLANATION OF THE ILLUSTRATION

PLATE XXXI. Typical cobs of Early Nal-Tel, Type B. These are similar to the cobs of Type A, but are slightly larger and usually ten-rowed. Natural size.

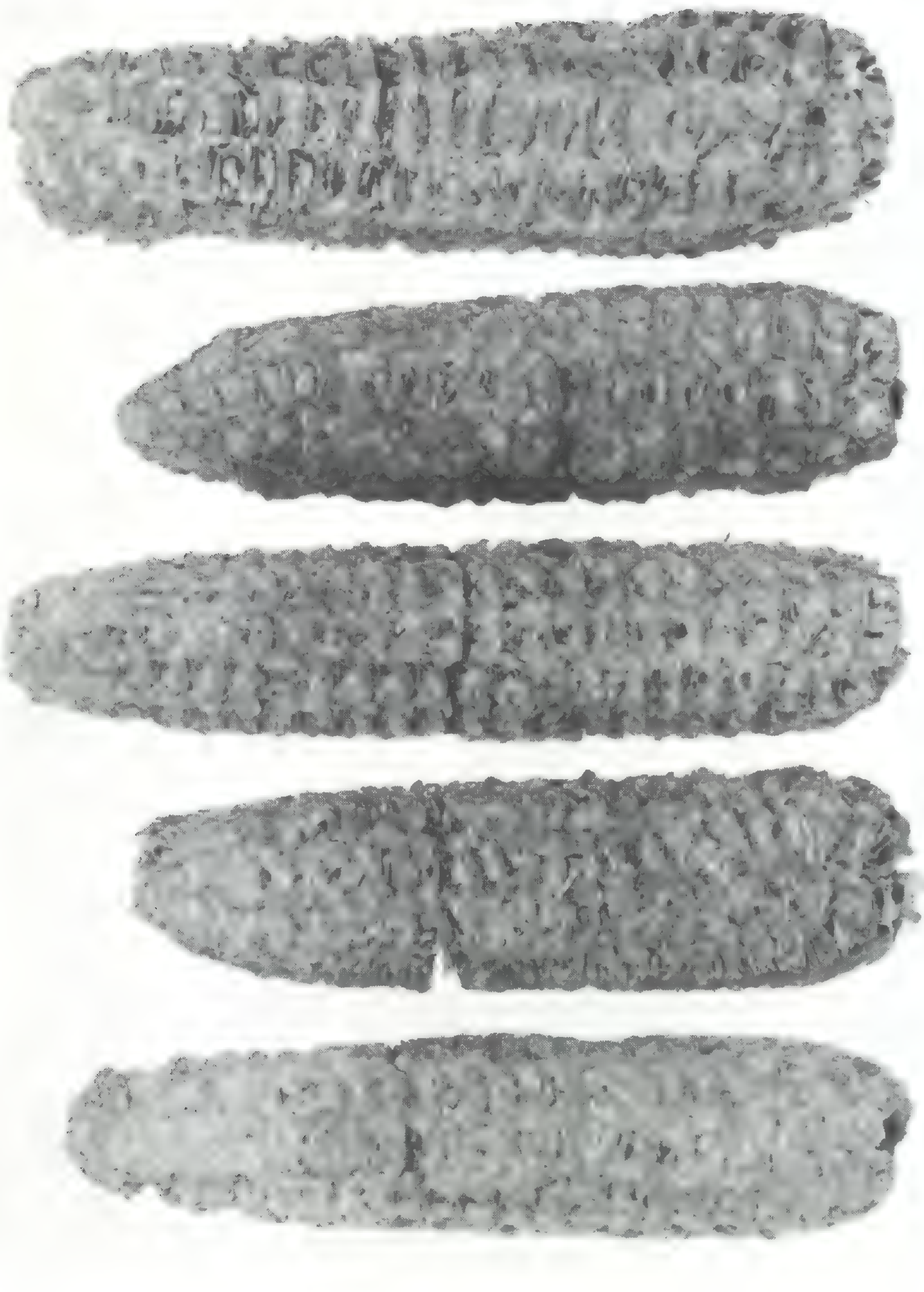
Plate XXXI



EXPLANATION OF THE ILLUSTRATION

PLATE XXXII. Typical cobs of Late Nal-Tel. These are almost identical with those of modern Nal-Tel, an ear of which is illustrated in Plate XXX. Natural size.

Plate XXXII



EXPLANATION OF THE ILLUSTRATION

PLATE XXXIII. *Left*. Two cobs resembling those of the race Dzit-Bacal, which is common in Yucatan and Campeche. *Right*. Two cobs resembling those of the race Breve de Padilla, a modern race of maize grown in the state of Tamaulipas, Mexico. Natural size.

Plate XXXIII

EXPLANATION OF THE ILLUSTRATION

PLATE XXXIV. The rachis and cupules of an extreme form of Early Nal-Tel, showing prominent rachis flaps and hairy cupules. The phytomers are loosely joined and the cob disarticulates easily. These may be primitive characteristics. Ten times natural size.

Plate XXXIV

EXPLANATION OF THE ILLUSTRATION

PLATE XXXV. Zapotec funerary urn from Monte Alban, Oaxaca, Mexico, the headdress adorned with moulds of ears of maize which resemble the modern race Nal-Tel. Courtesy of the National Museum, Mexico, D.F.

Plate XXXV

EXPLANATION OF THE ILLUSTRATION

PLATE XXXVI. Funerary urn from Oaxaca, Mexico, decorated with two moulds of ears of maize which resemble in length, shape and row number the cobs of Early Nal-Tel from La Perra Cave. After Caso and Bernal, 1952.

Plate XXXVI

EXPLANATION OF THE ILLUSTRATION

PLATE XXXVII. *Left.* A young ear-shoot of maize, partly chewed. *Center and right.* Well-chewed quids of young ears with husks attached. Apparently, one primitive use of maize was the chewing of ear-shoots and young ears for their sugar. Natural size.

Plate XXXVII

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ARCHAEOLOGICAL EVIDENCE ON THE EVOLUTION OF MAIZE IN NORTHWESTERN MEXICO

BY

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DESCRIPTION OF THE SITE

ARCHAEOLOGICAL investigations by one of the authors (Lister) were initiated in caves in the northern Sierra Madre Occidental of Mexico in the hope of contributing to the solution of a problem about which students of the cultures of the southwestern United States and central Mexico have frequently speculated—that of possible cultural connections between central Mexico and the American Southwest. Attempts made in the past to link the cultures of Mexico and the Southwest via the west coast of Mexico or the central plateau of northern Mexico have not succeeded. Therefore, attention was focused on the northern Sierra Madre, for it was known that caves containing archaeological material existed in the canyons of that region. Many of these caves were known to include cliff dwellings thought to be associated with the Casas Grandes, a relatively recent Puebloid culture whose remains are concentrated in the basins and valleys of northwestern Chihuahua. It was hoped that, by digging beneath the cliff dwellings, earlier deposits would be encountered and that some of these earlier levels would rep-

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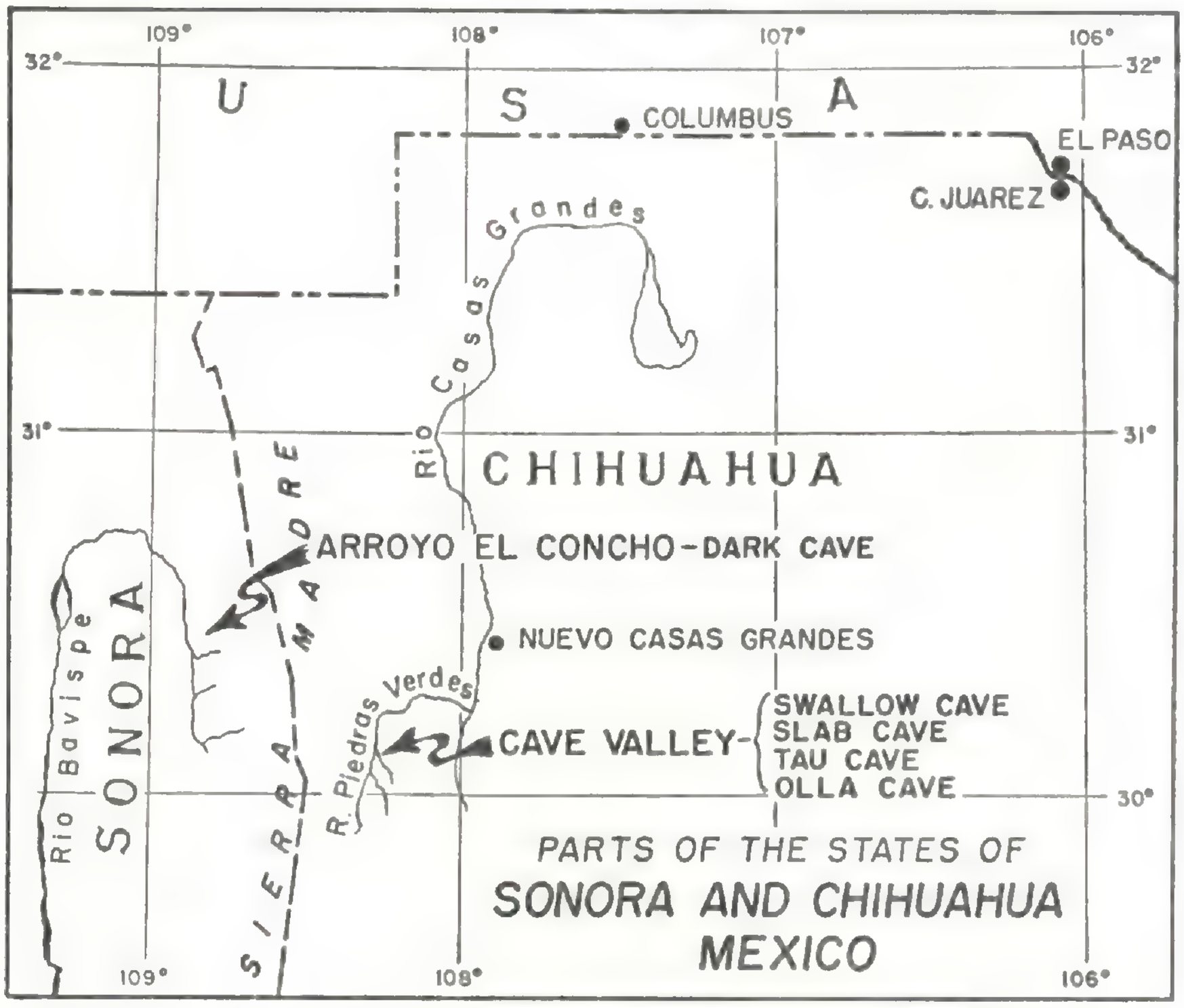
resent a period during which such basic culture elements as agriculture and pottery-making were first spreading from Mexico to the Southwest. It is a satisfaction to be able to report that these hopes have been, in part at least, realized.

In 1952, 1953, and 1955, twelve caves in northwestern Mexico were excavated, five of which contained specimens of prehistoric maize. This paper will not attempt to describe or discuss the archaeological features of these caves in any detail since a report on this subject is nearing completion and will soon be published. The brief archaeological summary and descriptions of cultural stratigraphy which follow are intended only to "set the stage" for the discussion of the maize recovered during the excavations.

The caves investigated are located in the Sierra Madre Occidental of northwestern Chihuahua and northeastern Sonora, Mexico. Most of the Sierra Madre in this area is a plateau surface into which rugged canyons have been cut by stream action. The plateau averages more than 5,700 feet in elevation, with a maximum rise to over 8,200 feet along the crests of the highest ridges. Dissected basins separated by low ridges occupy the areas between canyons. Geologically, the Sierra Madre is composed of a long series of effusives, volcanic material or surface lava, generally lying above intrusive rocks such as porphyry, diorite, and andesite. In places, andesite and rhyolites compose the higher ridges. Conglomerates and sandstones fill a number of old basins. Fertile soils produced by weathering of the volcanic mantle exist in the dales, basins and lower slopes of the ridges. The climate is predominantly temperate; however, one of Mexico's cold poles is in the higher mountains. Nearly three-quarters of the total annual precipitation of 24 inches falls in the summer months of July, August, and

September. Snow occurs in the higher elevations during the winter. The plateau top of the Sierra Madre Occidental is clothed with a fairly pure stand of open pine, which covers the ridges and descends to the bottoms of the upper canyons. The lower canyon slopes and basins have a characteristic juniper-oak-agave association.



Map of parts of the states of Sonora and Chihuahua, Mexico, showing the location of the five caves from which the archaeological maize described in this paper was collected.

Four of the caves from which maize specimens were collected are located in a canyon of the Rio Piedras Verdes in Chihuahua, known to local inhabitants as Cave Valley. This is an area which presented almost ideal living conditions to the Indians who formerly occupied it; today it is settled by Mexican farmers. The interbedded volcanic formations that border the Piedres Verdas have weathered in varying amounts to produce numerous caves and ledges, many of which were occupied by the

aboriginal peoples of the area. Cliff dwellings had been constructed in many of these caves and rock shelters. Refuse deposits of great antiquity exist beneath some of the cliff dwellings and in other caves in which no habitations were built. The agricultural lands of these peoples were located in the wider sections of the canyon bottoms, the tributary arroyos, and on the adjacent slopes. Numerous rock retaining walls, thought to have been associated with agricultural practices, still stand along arroyos and steeply sloping areas of cultivable land.

Swallow Cave. This cave, one of the four located in Cave Valley which contained maize, produced the best archaeological record and the most significant sequence of maize specimens of all the caves examined. Swallow Cave, like the others in Cave Valley, to be mentioned below, is situated about 100 feet above the canyon floor at the top of a steep brush- and tree-covered talus slope (Plate XXXVIII). The cave has a mouth approximately 160 feet in width, and it extends into the cliff to a depth averaging 40 feet. The ceiling is very irregular, but its height is greater than 11 feet throughout most of the central portion. Many large blocks of stone, which had fallen from the ceiling or spalled from the walls, littered the floor. Dirt containing cultural material covered the remainder of the surface. The poorly preserved remains of an adobe-walled structure were located adjacent to a large rock at the northern end of the cave.

Stratigraphic test trenches, from which dirt was removed in 6-inch levels and carefully sifted for archaeological specimens, were dug in Swallow Cave, as well as the other sites to be discussed. In Swallow Cave, trenches 2 and 3, dug adjoining one another in the southern portion of the cave, and an exploratory trench, placed next to the adobe structure mentioned above, produced maize

specimens in association with stratigraphically arranged archaeological material. The deposits in trenches 2 and 3 contained abundant potsherds and other archaeological specimens to a depth of 24 inches (through Level 4); from 24 inches to 42 inches (Levels 5–7) potsherds were scarce, as were other types of archaeological remains; below 42 inches and to the cave floor, reached at a depth of 96 inches (Levels 8–16), the deposit contained no potsherds. However, cultural remains in the form of utilized flakes of stone, charcoal, acorns, and corn cobs were present in these lower levels. The lowest maize came from Level 14.

The exploratory trenching around the adobe wall in Swallow Cave produced a selection of maize from the surface of the cave to a depth of 18 inches. Potsherds were frequent in these deposits.

Slab Cave. This cave is situated adjacent to Swallow Cave and is slightly smaller than the latter. Over half of the floor is covered by large slabs of rock which apparently had fallen from the ceiling. Only shallow deposits, averaging one foot in depth, were present. Potsherds and other archaeological specimens were associated with maize throughout the deposit.

Tau Cave. Located on the same cliff face as Swallow and Slab Caves, Tau Cave has a narrow entrance and then opens out into a circular cavern about 50 feet in diameter. Most of the floor consists of rock. Only around the walls were there accumulations of dirt containing cultural remains, and these were shallow. From these deposits, maize and other archaeological remains, including potsherds, were collected.

Olla Cave. The best-known archaeological site in Cave Valley is Olla Cave. Within the cave is a well-preserved

fifteen-room cliff dwelling and a large grass and mud granary shaped like a water jar or *olla* (Plate XXXVIII). Trenches were dug beneath the floors and walls of the house and in a corridor-like extension of the cave behind the structures. Below the house, 18 inches of dirt containing cultural objects were revealed before the floor was reached. In the rear only the first three levels (18 inches) of a test trench produced refuse and artifacts; however, two human burials were encountered in pits which had been dug to lower depths. Potsherds and maize were present throughout the deposits.

Dark Cave. The fifth cave which yielded the maize discussed in this report, Dark Cave, is located in Sonora approximately 35 airline miles northwest of Cave Valley in a narrow canyon which is known as Arroyo el Concho. This area does not appear to have been as favorable to occupancy by man as was Cave Valley and fewer archaeological sites are located there. A number of caves suitable for occupation exist high on the steep cliffs of the canyon, but the only lands available for cultivation in the area are on precipitous mountain slopes or in narrow arroyos. That these areas were utilized for agricultural purposes is suggested by the presence of numerous rock walls. The canyon was dry at the time of our visit; however, it was obvious that considerable water flows through it at times. A deep stream bed had been cut in the canyon bottom and boulders and rock outcrops have been eroded by running water.

Dark Cave is one of four caves located about 200 feet up the side of the canyon at the top of a talus slope. It has two chambers each approximately 30 feet in diameter situated one behind the other. A cliff dwelling comprising eight rooms in the outer chamber and four rooms in the dark inner chamber had been constructed in the cave.

Trenches were dug in both chambers. Deeper deposits were encountered beneath the structures in the rear chamber. Trench 4 was dug to a depth of 36 inches (six levels) before the rock floor was struck. Cultural remains, including maize, were encountered throughout the deposits.

Cultural Sequences and Affiliations

The analysis of the archaeological remains from the five caves described above, and from seven other caves in the northern Sierra Madre Occidental, provides data which are helpful in characterizing the prehistoric cultural sequence in that region, in setting up an affiliation with a culture in a neighboring area, and to a certain extent, in dating the remains.

It is the opinion of the junior author that the archaeological data furnish the basis for establishing a Chihuahua branch of Mogollon culture. Prior to our research, it was believed by some (Brand, 1953) that the cliff dwellings of the Sierra Madre represented a final stage of Casas Grandes culture. It was postulated that this southern extension of Pueblo culture had developed in the valleys and basins to the east and had then spread to the mountains as a result of pressure of nomadic peoples. This move provided more protective sites at a sacrifice of agricultural land. Other students felt that the cliff dwellings in the mountains, as well as a number of open sites to the east, represented the earliest well-developed phases of Casas Grandes culture (Sayles, 1936). These individuals noted the Pueblo features of Casas Grandes culture, but felt that its earliest manifestation showed relationships to the Mogollon culture which had been recognized to the north in southwestern New Mexico and southeastern Arizona (Sayles, 1936; Gladwin, *in* Sayles, 1936). The above deductions were made mainly as a result of archae-

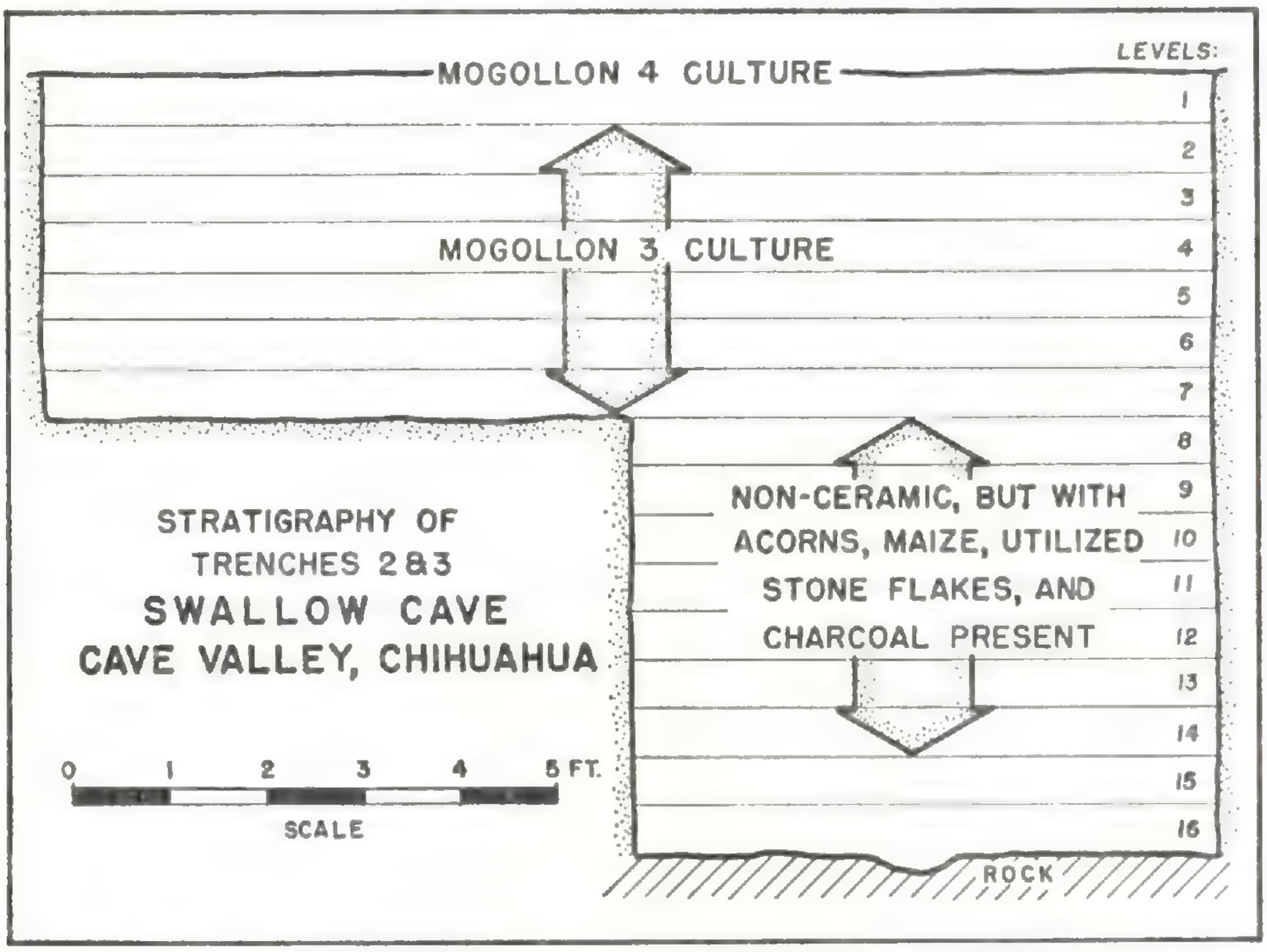
ological reconnaissance and survey in the Sierra Madre sites which involved only limited excavations.

It is now believed that neither of the above concepts is completely correct, but that the one proposed by Sayles and Gladwin comes closest to the situation as it has been revealed by these recent studies. Instead of labelling the culture associated with the cliff dwellings as Casas Grandes, it seems preferable to define it as Mogollon. Also, the cultural remains below the cliff dwellings and buried beneath the surfaces of caves containing no habitations, or simply a few wall remains, are likewise Mogollon. It is assumed that the Casas Grandes culture developed from a Mogollon base and spread eastward from the mountains into northwestern Chihuahua and southwestern New Mexico. One cave, Swallow Cave, produced deeply buried culture-bearing strata lying below Mogollon culture.

As a result of these investigations, the culture history in the northern Sierra Madre Occidental may be briefly summarized as follows:

1. The earliest remains encountered were those found in the lower levels (Levels 8-14) of trenches in Swallow Cave. No pottery occurred in these strata, but maize, acorns, charcoal, and utilized flakes of stone clearly indicate an occupation of the cave. No evidence of permanent habitations was found, so it is assumed that the cave was simply used as a camping place during the period represented by these levels. The presence of maize unassociated with pottery is not unusual, for such occurrences have been reported a short distance to the north in Bat Cave, New Mexico (Mangelsdorf and Smith, 1949) and in other caves in southwestern New Mexico (Martin *et al*, 1952). Cultural remains from this horizon in Swallow Cave pre-date the Mogollon material found above them which is described in the following paragraphs. How-

ever, since our Mogollon remains are not early Mogollon, but probably assignable to the late Mogollon 3 period, they can be dated at approximately 900 A.D. (Wheat, 1955). Just how much earlier than 900 A.D. is the material from the lower levels of Swallow Cave is not known. The presence of maize 30–36 inches below the earliest Mogollon remains suggests that they are considerably



The stratigraphy of two trenches in Swallow Cave, Chihuahua, Mexico, from which the majority of the cobs described in this paper were collected. From Levels 13 and 14, three cobs representing a precursor of the modern Mexican race, Chapalote, were obtained.

older. No dates from radiocarbon have yet been obtained, although it is hoped that such dates may be forthcoming. It is felt that these remains, the earliest we have encountered in the northern Sierra Madre, strengthen the belief that early cultural connections did exist between Mexico and the southwestern United States and that a corridor for movement of such elements was the great Sierra Madre mountain massif with its series of north-south trending canyons.

2. Next in chronological order is the Mogollon culture. It is found in all of the caves we investigated. However, it is difficult to assign our material to definite phases as has been done to the north in New Mexico and Arizona. The rarity of long cultural sequences in most of the caves plus the small series of archaeological specimens makes such assessments enuous. A distinction can be made, however, between the Mogollon culture which is situated stratigraphically lower than the cliff dwellings and that which is associated with such structures.

The sub-surface remains in all caves except Swallow Cave, whose non-ceramic levels are discussed above, contain Mogollon culture remains extending to the rock floors of the caves. These deposits produced pottery, simple stone cutting and scraping implements, artifacts of bone, wood and fiber, and vegetal remains. In some caves there appear to be no habitations associated with these materials, but in others a few poorly preserved mud wall foundations and buried posts suggest houses. These structures, however, are not of the type referred to as cliff dwellings in this paper. They appear to be remains of earlier structures. The pottery is almost exclusively typical of that associated with Mogollon culture. The principal types include: Alma Plain, Alma Scored, Alma Incised, Neck Corrugated, and Incised Corrugated. Although some of these pottery types were common throughout Mogollon history, the presence of certain of them would indicate that the deposits are no earlier than late Mogollon 3, approximately 900 A. D. (Wheat, 1955). Red on brown pottery also is present. Such a pottery tradition agrees with Mogollon, but it is difficult to classify our red on brown sherds as belonging to any previously described type.

3. The most recent remains in the caves, those occurring on the surfaces, were always associated with cliff

dwellings. For the most part, such structures were well preserved and varied in size from a single room to fifteen-room establishments. Archaeological specimens from the surface, or from the first six inches below the surface (Level 1), continued to be of Mogollon culture. Objects of perishable materials such as cordage, matting, textiles, basketry, wooden artifacts, and vegetal remains were fairly prevalent. Stone artifacts and potsherds were more numerous from this horizon than from lower levels. In addition to the Mogollon wares found in the sub-surface deposits, late types such as Plain Corrugated, Smooth Corrugated, and Alma Punched also appeared. Presence of these wares suggests that the material should be assigned to the Mogollon 4 period, approximately 1000 A.D. (Wheat, 1955).

A few potsherds of textured, black on red, and polychrome wares collected from the cave surfaces belong to types assignable to the Casas Grandes culture. It is believed that these represent trade items, since they do not occur frequently enough to suggest local manufacture. The few Casas Grandes potsherds found in the caves belong to wares attributed to the Medanos and Babicora phases, the earliest phases of Casas Grandes culture. Dates of 1000–1100 A.D. have been assigned to these (Sayles, 1936; Gladwin, *in* Sayles, 1936).

Description of the Maize

Once again the botanist is indebted to the archaeologist for furnishing, in the form of prehistoric specimens, highly significant evidence on the evolution of maize. The archaeological maize from these five caves in northwestern Mexico is of extraordinary interest for five reasons: 1) The majority of the specimens are related to a primitive race of maize, Chapalote, which is still grown in Mexico; 2) The earliest archaeological maize appears

to be a precursor of this modern but primitive race; 3) There is evidence of the introduction of an eight-rowed flour corn originally from South America; 4) There is evidence of hybridization with teosinte; 5) These several entities are finally blended into a modern race of maize, Cristalino de Chihuahua, which is grown in Chihuahua today and which has affinities with the maize of the American Southwest.

The botanist is also indebted, in this instance, to the corn breeders of Mexico who, from strictly utilitarian motives, collected, classified, and described the living races of maize of that country. Their monograph on the subject (Wellhausen *et al*, 1952), with its detailed descriptions and excellent illustrations has furnished the clues to the identity of all of the different types of prehistoric maize collected from the five caves described above.

The Principal Types

The prehistoric cobs from these caves comprise five recognizable types, four of which still occur in the states of Sonora or Chihuahua. The remaining type is a now-extinct precursor of one of the four living types. The material from only one of the five caves, Swallow Cave, is sufficiently abundant and varied to show an evolutionary series. The specimens from the other four caves are useful in furnishing corroborative evidence.

Pre-Chapalote. The earliest intact cob, from Swallow Cave, comes from Level 13. This is a carbonized specimen, 3.5 cm. long, having twelve rows with an average of nine kernels per row. In shape, it is quite similar to the earliest cobs from Bat Cave in New Mexico, dated by associated charcoal at 5000 years or more (Libby, 1951), with which it is compared in Plate XXXIX, in-

set. It also resembles the Bat Cave corn in having prominent rachis flaps, cupules widely spaced on the rachis, and long rachillae. It differs from the Bat Cave corn in the surfaces of the cupules, which are quite hairy. Two fragments of cobs, one from the same level and another from an earlier level (14), resemble the intact specimens in their cupules and are therefore presumed to be specimens of the same race.

This early maize from Swallow Cave also shows a resemblance to the modern race, Chapalote, which occurs in the western part of Mexico, and which has been collected from the states of Sinaloa and Sonora (Wellhausen *et al*, 1952). The cob of the early Swallow Cave corn is much shorter than that of modern Chapalote (illustrated in Plate XLV), but it has the same shape, tapering at both ends; the same row number, twelve, and prominent rachis flaps. Of the living races of maize in Mexico today, Chapalote seems to be the only one which could be the modern counterpart of the earliest Swallow Cave corn and we are therefore designating the latter as "Pre-Chapalote."

Early Chapalote. The next recognizable element in the Swallow Cave cobs is clearly related to Chapalote. This type has the characteristic shape of Chapalote, tapering at both ends; it has approximately the same row number, twelve; prominent glumes, perhaps representing a weak allele of tunicate, which Chapalote is known to possess (Mangelsdorf, 1953); and prominent rachis flaps. Cobs of this type, designated as "Early Chapalote" are found in several of the caves. Specimens from Swallow and Slab Caves are illustrated in Plate XL.

Further evidence that Chapalote, or something very much like it, was once grown in this region is provided by the extensive collections of kernels from Dark Cave.

Several thousand kernels of this type are available from Levels 5 and 6; almost all of these are very similar to the kernels of modern Chapalote in their size, shape, and brown pericarp color. Chapalote is the only race in Mexico which has brown pericarp color. The resemblance between the kernels of modern Chapalote and the archaeological specimens is well illustrated in Plate XXXIX, inset.

Tripsacoid Maize. Beginning with Level 2 in Swallow Cave, there is evidence of maize which has been modified by teosinte introgression. Included in this type, designated as "Tripsacoid," are small cobs with strongly indurated glumes and occasional single spikelets or partially aborted second, or pedicellate, spikelets. There is even more evidence of this introgression in certain of the specimens from the surface layer, some of which have strongly indurated crateriform lower glumes, which are set at right angles to the rachis like the teeth of a coarse wood rasp. Glumes of this kind are quite characteristic of certain segregates from maize-teosinte hybrids, and some of these archaeological specimens, like those described by Galinat *et al* (1956), can be almost exactly duplicated by modern specimens obtained from experimental cultures. The combination of indurated glumes and single or partially aborted spikelets leaves little doubt that there has been introgression of teosinte into the maize of Chihuahua in prehistoric times. Teosinte is fairly common in western Mexico and has been collected in the state of Chihuahua. Furthermore, Lumholtz reports that the Indians of western Mexico practiced the custom of interplanting maize and *maizillo* (probably teosinte) for the purpose of improving their maize. Plate XLI shows Tripsacoid cobs from Swallow Cave. The same evidence of teosinte introgression is to be found in the cobs from other localities.

Harinoso de Ocho. First becoming evident in Level 2 of Swallow Cave, there has come into the evolutionary picture an eight-rowed large-seeded corn, similar to Harinoso de Ocho (illustrated in Plate XLVI), which is still occasionally found in western Mexico in the states of Sinaloa and Sonora. Wellhausen *et al* (1952) described this race and postulated that it was introduced into Mexico from South America in pre-Columbian times. It has subsequently been found in Colombia, where it is known as "Cabuya" (Roberts *et al*, 1955). This race also shows some resemblance to the prehistoric flour corn of Cañon del Muerto, described by Anderson and Blanchard (1942), and it probably has affinities with the eight-rowed flour corn of the Northern Plains Indians, especially the Mandan. Specimens of archaeological cobs of this type of corn are illustrated in Plate XLII and a single kernel from Dark Cave is illustrated in Plate XLIV, Fig. A.

Cristalino de Chihuahua. The fifth type of corn in Swallow Cave is (with the exception of two cobs in Level 3, which may be intrusions) found only in Levels 1 and 2. The cob of this maize is larger than that of any of the preceding types, is more or less cylindrical in shape, and represents an excellent blending of the characteristics of the three preceding entities: Chapalote, Tripsacoid maize, and Harinoso de Ocho. The cobs of this maize have their counterparts in a modern race collected in Chihuahua and described by Wellhausen *et al* under the name Cristalino de Chihuahua (Plate XLVII). The archaeological cobs are shorter than typical cobs of the modern race, but in other respects they are quite similar. Furthermore, the kernels from several of the caves resemble the kernels of the modern race, in being thick, flinty, sometimes slightly dented, and predominantly white. This type of corn has affinities with the modern

corn of some of the Southwestern Indians. We have found counterparts of it in both Zuni and Navaho maize.

Some of the cobs of Cristalino de Chihuahua have a very definite "honeycomb" aspect, which results from the deep pockets formed by the upper and lower glumes. This represents a combination of characteristics provided by the three separate elements which have gone into this maize. Chapalote has contributed long glumes; as already mentioned, it is known to have an allele at the tunicate locus. Harinoso de Ocho has contributed thickness to the glumes; and introgression from teosinte has caused the glumes to be slightly indurated. By crossing segregates from maize-teosinte hybrids with a stock carrying the gene for half tunicate, we have produced specimens of modern maize which duplicate these cobs very closely. These deep pockets on the cob are characteristic also of some of the maize of the Indians of the Southwest.

Detailed Descriptions

The specimens from the several caves are described in detail below:

Swallow Cave

Trench 3, Level 14 (78–84″). Fragments of a carbonized cob, containing the same type of cupules that are found in the intact cob from Level 13. The cupules are about as broad as long, the upper margin being slightly indented at the center, giving the cupule a broad, heart-shaped appearance. There is an indication that the cupules are widely spaced; their surface is hairy. These fragments probably represent cobs of Pre-Chapalote.

Trench 3, Level 13 (72–78″). One intact cob carbonized, slightly flattened, 3.5 cm. long, with twelve rows, nine kernels per row. Shape of cob similar to those of earliest Bat Cave corn. Other similarities: cupules widely

spaced on rachis, prominent rachis flaps. The cupules differ from those of Bat Cave corn in being slightly broader than long and in being more hairy. The rachillae are long.

A fragment of cob from this level apparently belongs to the same race, since it is twelve-rowed and has similar cupules. This fragment is somewhat flattened. Both of these specimens represent Pre-Chapalote.

Trench 3, Level 3 (12–18″). One intact cob, 7.5 cm. long, with ten rows, tapering at both ends. This is probably an early form of modern Chapalote.

Six fragments with twelve, eight, ten, ten, eight, ten rows respectively.

Two fragments representing eight- and ten-rowed cobs with long glumes; both upper and lower glumes are thick and fleshy. These are similar to some of the cobs from the surface layer. They may be intrusions.

Trench 3, Level 2 (6–12″). Three intact cobs, 6, 7, and 7.5 cm. in length, ten-rowed, tapering at both ends, similar to the intact cob in Level 3, and, like it, probably representing an early form of Chapalote.

One intact cob, 5 cm. long, six-rowed, highly Tripsacoid; indurated glumes and rachis; crateriform lower glumes; some single spikelets. The specimen can be matched almost exactly by segregates from maize-teosinte hybrids. An additional fragment, badly eroded through charring, may also be Tripsacoid.

Twenty fragments, predominantly ten-rowed, all of which resemble, in general characteristics, the intact cobs of Early Chapalote.

Five fragments of an eight-rowed maize with a slender cob and glumes, a combination of characteristics which suggests that the cobs bore large kernels. These are related to Harinoso de Ocho.

Six fragments of a type similar to the modern race Cristalino de Chihuahua. Ten- to twelve-rowed; long glumes; both upper and lower glumes thick and slightly indurated.

Trench 3, Level 1 (*0–6″*). One intact cob, 4.5 cm. long, ten-rowed, highly Tripsacoid. Rachis and glumes strongly indurated; a few single spikelets.

Six fragments approaching Chapalote in type; five which approach Harinoso de Ocho, and three which are similar to those of Cristalino de Chihuahua.

One kernel, broad, flinty and brown in color.

Structures 1 and 2 (*0–18″*). The intact cobs comprise two distinct groups. The first includes eight cobs of the type Cristalino de Chihuahua, which results from the blending of the characteristics of earlier elements—Chapalote, Harinoso de Ocho, and teosinte. The cobs are medium to long, 10, 12, 13, 13, 14, 17.5 and 23 cm. respectively. They are predominantly ten- to twelve-rowed with long, thick glumes which are slightly indurated.

The second group, comprising ten intact cobs, are all highly Tripsacoid. Lengths 6.5, 7.5, 8, 8.5, 8.5, 9, 9, 9.5, 9.5, 11 cm.; all have indurated glumes and rachises. In some specimens, the glumes are crateriform and highly indurated. There are no single spikelets; but in several of the specimens, the second, or pedicellate, spikelet is greatly reduced in size—a condition which represents a transition between double and single spikelets, and one which is common in segregates of maize-teosinte hybrids.

The cob fragments from this level, comprising 32 specimens, fall into three more or less distinct groups. The largest number, thirteen, are similar to the intact cobs of Cristalino de Chihuahua mentioned above. The second group, comprising ten fragments, are slender and

eight-rowed. These are pretty obviously cobs of Harinoso de Ocho, or something very much like it. The third group, comprising nine cobs, is intermediate between these. The cobs represent Harinoso de Ocho, only slightly modified by the introgression of other elements. They may be similar to the present-day "Maiz Blando de Sonora," described by Wellhausen *et al* (1952), which, in turn, has some similarity to the Pima-Papago corn of southern Arizona.

There are twelve unclassified fragments from this level.

No cobs which could be clearly assigned to Chapalote are found in this surface level. Apparently, this primitive race was almost completely replaced by Harinoso de Ocho and the modern race evolving from the amalgamation through hybridization of earlier races.

Slab Cave

Trench 2 *(0–12″)*. Five intact cobs, 6.5, 7.5, 7.5, 10, and 9 cm. in length. The first four appear to be cobs of a short-eared form of Chapalote. The last resembles Harinoso de Ocho. Three additional intact cobs, 5.5, 5.5, and 6 cm. in length, are Tripsacoid with indurated glumes and rachises and a slight tendency towards suppression of one member of a pair of spikelets. Two fragments are also Tripsacoid.

The remaining fragments can be separated into three more or less distinct groups. The first, comprising eleven specimens, shows some resemblance to cobs of Chapalote. The second group, nine specimens, are related to Harinoso de Ocho; and the third group, also nine specimens, are similar to the most recent maize from Swallow Cave, which, as already mentioned, is similar to the modern Cristalino de Chihuahua.

The collection from this test trench includes 82 well-preserved kernels, of which fifteen have brown pericarp.

The kernels are thick, wedge-shaped and flinty; and, in these respects, resemble the kernels of Cristalino de Chihuahua. There are no typical kernels of Chapalote, but the influence of this race is apparent in the brown pericarp of a small percentage of the kernels.

Olla Cave

Trench 2, Level 1 (*0–6″*). No intact cobs; ten fragments which may be related to Chapalote; three fragments which show some resemblance to Harinoso de Ocho; one fragment resembling Cristalino de Chihuahua; and three fragments of Tripsacoid cobs. Six kernels (two brown, one red, one yellow, and two white); one of the brown kernels is exactly like those of Chapalote; one of the white kernels is like those of the modern Cristalino de Chihuahua.

Trench 1, Level 1 (*0–6″*). Two intact cobs, both 5 cm. long, both Tripsacoid; and an additional fragment which is Tripsacoid. Of the remaining ten fragments, nine can be assigned to Chapalote and one to Harinoso de Ocho. Five kernels (two brown, one red, one yellow, one white); one brown kernel is typical of Chapalote.

Tau Cave

Trench 1 (*0–18″*). Two intact cobs, 6 and 10 cm. long. The first is a highly Tripsacoid cob with stiff, indurated crateriform glumes and indurated rachis. There is a slight tendency towards the suppression of one spikelet of the pair. The second cob has relatively long, soft glumes and is similar to Chapalote. Three cob fragments resemble Cristalino de Chihuahua, being large in diameter and possessing deep pockets, formed by long, thick, slightly indurated glumes. Seventy-two kernels, of which 63 are brown, one red, and eight white. The brown kernels are

predominantly short and broad, flinty in endosperm texture, and, except for being slightly larger, are similar to those of Chapalote.

Dark Cave

Trench 4, Level 6 *(30–36″)*. About 775 kernels (182 grams, kernels weighing 23.6 grams per hundred). The kernels are almost identical in size, shape and color to the kernels of modern Chapalote (Plate XXXIX, inset, Figs. C and D). A few kernels have red pericarp.

Trench 4, Levels 5 and 6 *(24–36″)*. About 3,000 kernels (709 grams, kernels weighing 23.2 grams per hundred). Like the kernels from Level 6, these are similar to modern Chapalote in size, shape and color. There is very little evidence that this race, at this stage, has been modified by the introgression of other races.

Trench 4, Level 1 *(0–6″)*. One fragment similar to Cristalino de Chihuahua, Five kernels (Plate XLIV); three are small and brown like Chapalote; one is small, white and flinty; one is large and broad, and similar in size and shape to the kernels of modern Harinoso de Ocho. It is the only one from any of the caves referable to this category. It is possible that large, floury kernels would not have been as easily preserved as flinty kernels of other races.

Archaeological Levels and Types of Maize

The relationship between archaeological levels and types of maize is simple, direct, and obvious: 1) All of the maize from the lower levels, 3 to 14 (with the possible exception of two intrusions in Level 3 of Swallow Cave), is related to Chapalote—the only type of maize found at the lower levels; 2) The maize of the upper levels, 1 and 2, comprises four types, Chapalote, Tripsa-

coid, Harinoso de Ocho, and Cristalino de Chihuahua. All four types are present in Swallow, Slab, and Olla Caves. Tau Cave and Dark Cave each lack specimens of one of these types, Harinoso de Ocho and Tripsacoid respectively, but in both cases the total number of specimens is small and the absence of one of the four types has no significance.

The Evolutionary Sequence

The sequence of steps in the evolution of maize in northwestern Mexico is reasonably clear. All of the early maize, whether from Swallow Cave in Chihuahua or Dark Cave in Sonora, is related to the living, but still primitive, race, Chapalote. The earliest maize of this type (from Levels 13 and 14 of Swallow Cave) is smaller and more primitive than modern Chapalote and is a precursor of it. During the period (perhaps a very long one) represented by the difference between Levels 13 and 14, and Levels 1 and 2 in Swallow Cave, there was, except for a slight increase in size, little change in this race. In this respect, the situation is similar to that described by Mangelsdorf *et al* (1956) in the maize of northeastern Mexico, where another ancient indigenous Mexican race, Nal-Tel, remained remarkably constant during a long period of time.

This gradual evolution within a single race was suddenly interrupted when two new entities, an eight-rowed maize originally from South America and Tripsacoid maize, became involved in the evolutionary sequence. With almost explosive rapidity, these three elements now fused to produce an entirely new and highly advanced race of maize similar to the modern race of Cristalino de Chihuahua. This spectacular evolutionary spurt can be accounted for by three genetic phenomena: genetic recombination, heterosis, and the mutagenic effects

of teosinte introgression. Of these three, the last, a phenomenon only recently recognized (Mangelsdorf, 1953), may have been the most important. In any case, the maize of northwestern Mexico, in a short period of time, not more than several centuries at the most, was almost completely transformed.

Approximate Date of Evolutionary Changes

None of the maize specimens from these caves has yet been dated by radiocarbon determinations. Correlations of the cultural manifestations mentioned earlier in this paper suggest that the most recent archaeological remains should be assigned to about 1000 A.D. The sudden changes begin in Level 2 which must represent a date slightly earlier, perhaps about 900 A.D. It is interesting to note that Martin *et al* (1952) in studying the maize from Tularosa Cave, found a gradual decrease in average row number which was attributed, in part, to the introduction of varieties with low kernel-row numbers from outside the area. It was assumed that some of these varieties were Tripsacoid. The change in row number was most sudden between the Georgetown and San Francisco phases (ca. 700 A.D.). Mangelsdorf and Smith (1949) found the earlier maize from Bat Cave to be non-Tripsacoid, while the more recent maize, especially that from Levels V and VI, included a high percentage of Tripsacoid specimens. Cobs from Level VI are dated by radiocarbon determinations at 1752 ± 250 years (Arnold and Libby, 1950) or, at the latest, about 450 A.D. But estimates based on pottery put this level at between 500 and 1000 A.D. More precise dating will undoubtedly become possible as the data from radiocarbon determinations and archaeological manifestations, from various sites, are correlated. In the meantime, it will suffice for our purposes to conclude that a very marked change in

the maize of northwestern Mexico and adjoining areas in New Mexico occurred at about 750±250 A.D.

The Diffusion of Maize from Northwestern Mexico

There can be little doubt that Chapalote, one of the ancient indigenous races of Mexico, was spread rather widely, and was the principal, if not the only race of maize of the early cultures in northwestern Mexico and the southwestern United States. Prehistoric remains of Chapalote, or something closely related to it, have been found by Kelly in the states of Jalisco and Sinaloa in Mexico (Anderson, 1944), by Anderson (1947) in the material from Painted Cave and by Hurst and Anderson (1949) in the maize from Cottonwood Cave in Colorado. Wellhausen *et al* (1952) have pointed out that some of the impressions of maize ears in a prehistoric block of lava from Morelia, Michoacan, Mexico, might well have been made by ears of Chapalote. Although the authors did not recognize it at the time, it now seems apparent that some of the early maize of Bat Cave described by Mangelsdorf and Smith (1949) is related to Chapalote. The cobs from Strata I and II of their Plate XXIII, as well as the kernels (Plate XXIV) are clearly related to this race. The Pre-Pottery maize from Tularosa Cave, illustrated by Cutler (*in* Martin *et al*, 1952), may also well be an early form of Chapalote.

Chapalote is unique among the Mexican races of maize in having brown pericarp color. The center for this character is in the highlands of Peru where brown and reddish-brown pericarp colors are common. Brown pericarp is also common among the prehistoric maize ears of coastal sites in Peru. Whether Chapalote came originally from South America, or whether brown pericarp in Peru derived originally from Mexico, or whether there is, indeed,

any significance in the fact that brown pericarp occurs in both Mexico and Peru, remain for the moment unanswered questions.

There seems little doubt, however, that the eight-rowed maize, Harinoso de Ocho, which features so prominently in the evolution of maize in northwestern Mexico, came originally from South America. And it seems quite probable that this race is related to the prehistoric flour corn of Cañon del Muerto described by Anderson and Blanchard (1942) and to various living races of maize including the Papago flour corn illustrated by Carter and Anderson (1945) and the eight-rowed flour corn of the Indians of the northern Great Plains, illustrated by Will and Hyde (1917).

The race, Cristalino de Chihuahua, like Chapalote and Harinoso de Ocho, seems to have spread throughout the American Southwest. Ears resembling it occur widely among the maize varieties of the Indians. Carter and Anderson (1945) in their study of southwestern maize varieties recognized two of the elements now identified in the archaeological specimens. One of these, a many-rowed maize with tapering ears, was designated as "Mexican"; the other, an eight-rowed corn with large kernels, was called "Eastern." In the light of the archaeological remains described above, it now appears that both of these elements are Mexican, the first, Chapalote; the second, Harinoso de Ocho.

All of the evidence combined points to the conclusion that the highlands of northwestern Mexico served as a corridor for the diffusion of maize from Mexico into the American Southwest.

Summary

1. Collections of prehistoric maize from five caves in Sonora and Chihuahua in northwestern Mexico are described.

2. The earliest prehistoric maize is a precursor of a living primitive race in Mexico, Chapalote.

3. There was little evolution, except for a slight increase in size, in this race during a long period of time.

4. At about 750 ± 250 A.D., the maize of northwestern Mexico began to change with explosive rapidity.

5. This sudden evolutionary spurt is attributed to the introduction into the area of two new entities, an eight-rowed flour corn originally from South America and Tripsacoid maize which had become modified by teosinte introgression.

6. These three entities combined to produce a new race, Cristalino de Chihuahua, which is assumed to be the product of genetic recombination, heterosis, and the mutagenic effects of teosinte introgression.

7. All of the races of maize which occurred prehistorically in northwestern Mexico are found archaeologically or as living maize in the Southwestern United States. It is postulated that the highlands of northwestern Mexico served as a corridor for the northward diffusion of maize.

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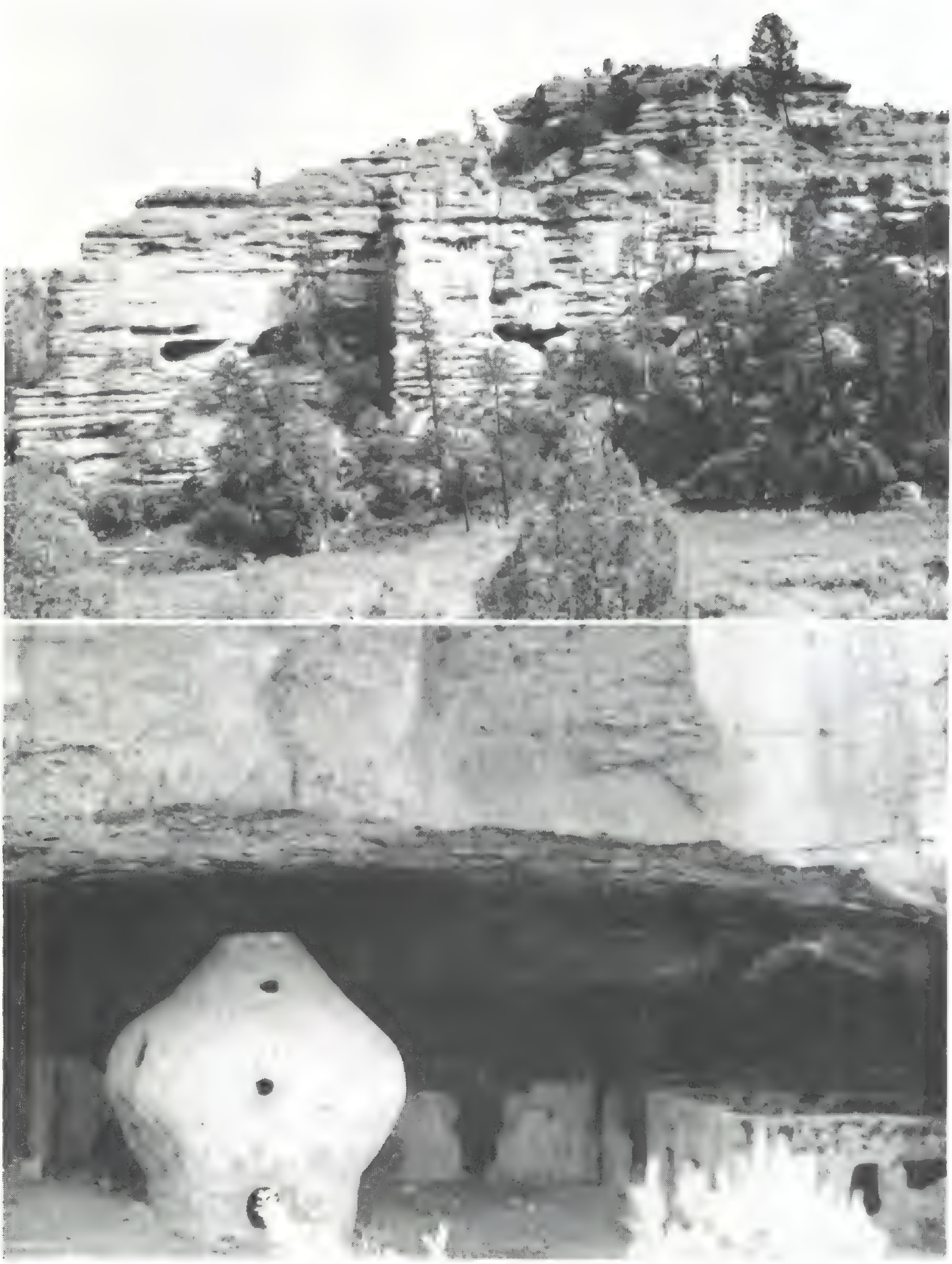
EXPLANATION OF THE ILLUSTRATION

PLATE XXXVIII. *Upper.* Swallow Cave, Slab Cave and Tau Cave (second, third and fourth from left, respectively) are located on the face of this cliff in Cave Valley, Chihuahua, Mexico. *Lower.* A view of the interior of Olla Cave, Chihuahua, Mexico, showing a granary in the foreground.

Plate XXXVIII

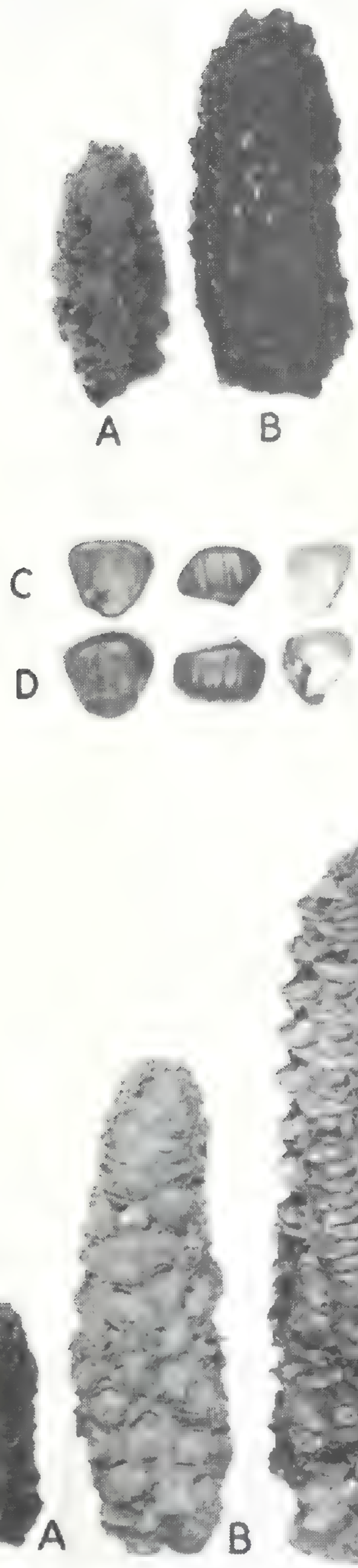


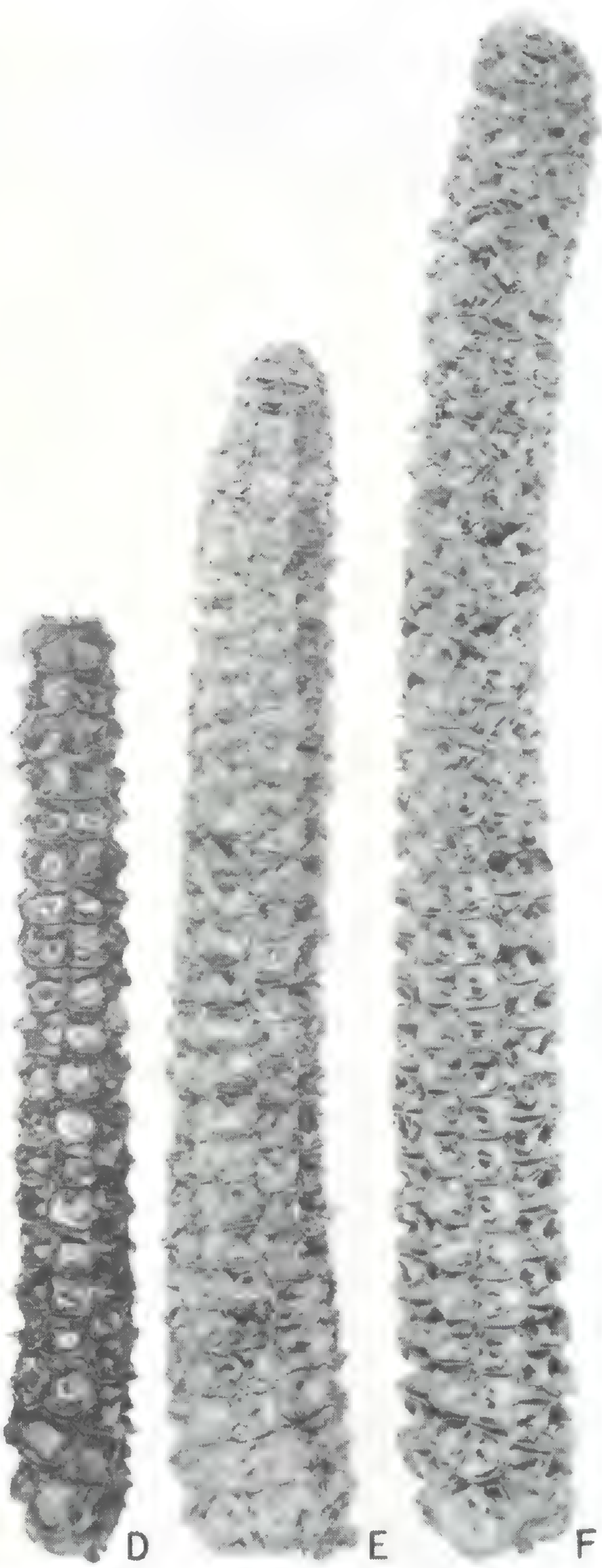
EXPLANATION OF THE ILLUSTRATION

PLATE XXXIX. Variation in the cobs from Swallow Cave. A, Pre-Chapalote from Level 13; B, Early Chapalote from Level 2; C, Tripsacoid cob from Structures 1 and 2; D, Harinoso de Ocho from same; E, Cristalino de Chihuahua from same; F, Long cob of Cristalino de Chihuahua from same, showing combination of long glumes and induration. About two-thirds natural size.

Inset. A, Earliest cob from Bat Cave, New Mexico. B, Earliest cob from Swallow Cave, Chihuahua, Mexico. Note the resemblance in shape between these two; C, Three views of kernels of modern Chapalote; D, Prehistoric kernels from Level 6, Dark Cave, Sonora, Mexico. Note similarities in size, shape and color, and in striations on dorsal surface. Natural size.

Plate XXXIX

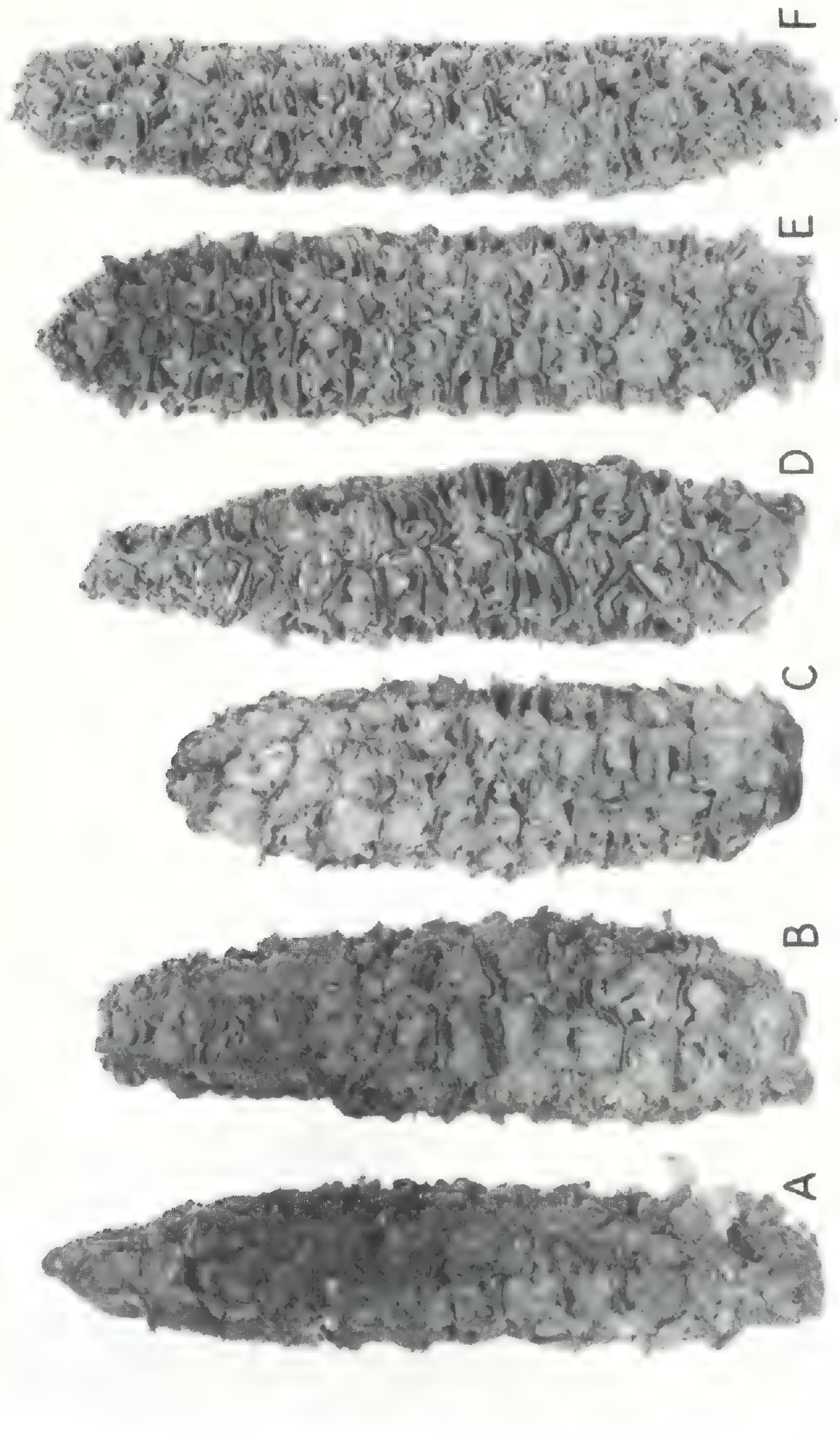




EXPLANATION OF THE ILLUSTRATION

PLATE XL. Cobs representing an early type of Chapalote from two caves in Chihuahua, Mexico. A, Swallow Cave, Level 3; B and C, Swallow Cave, Level 2; D–F, Slab Cave. Natural size.

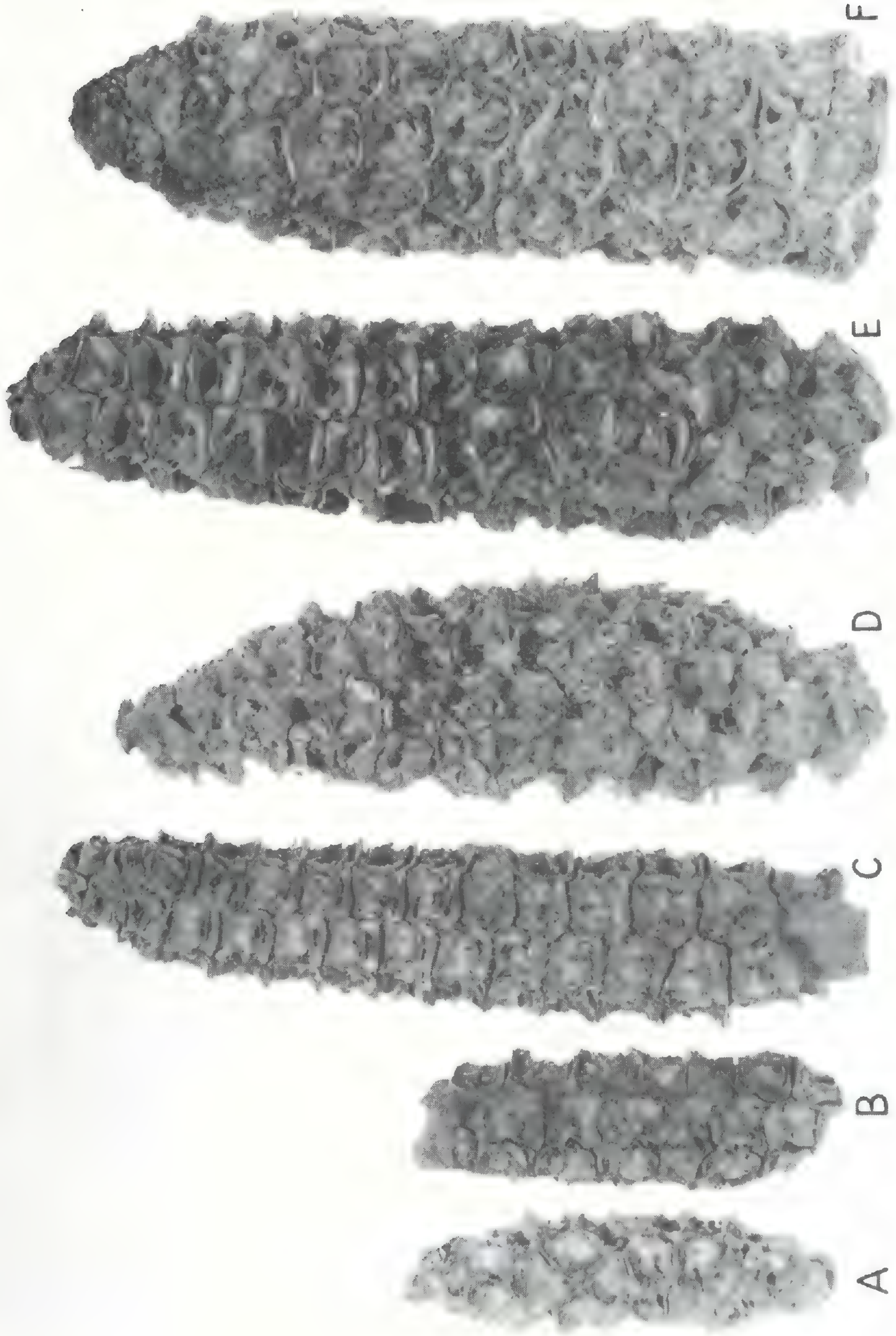
Plate XL



EXPLANATION OF THE ILLUSTRATION

PLATE XLI. Tripsacoid cobs from Swallow Cave. A and B, from Level 2; C–F, From structures 1 and 2. Note especially the stiff crateriform glumes in F. These are characteristic of certain segregates from maize-teosinte hybrids. Natural size.

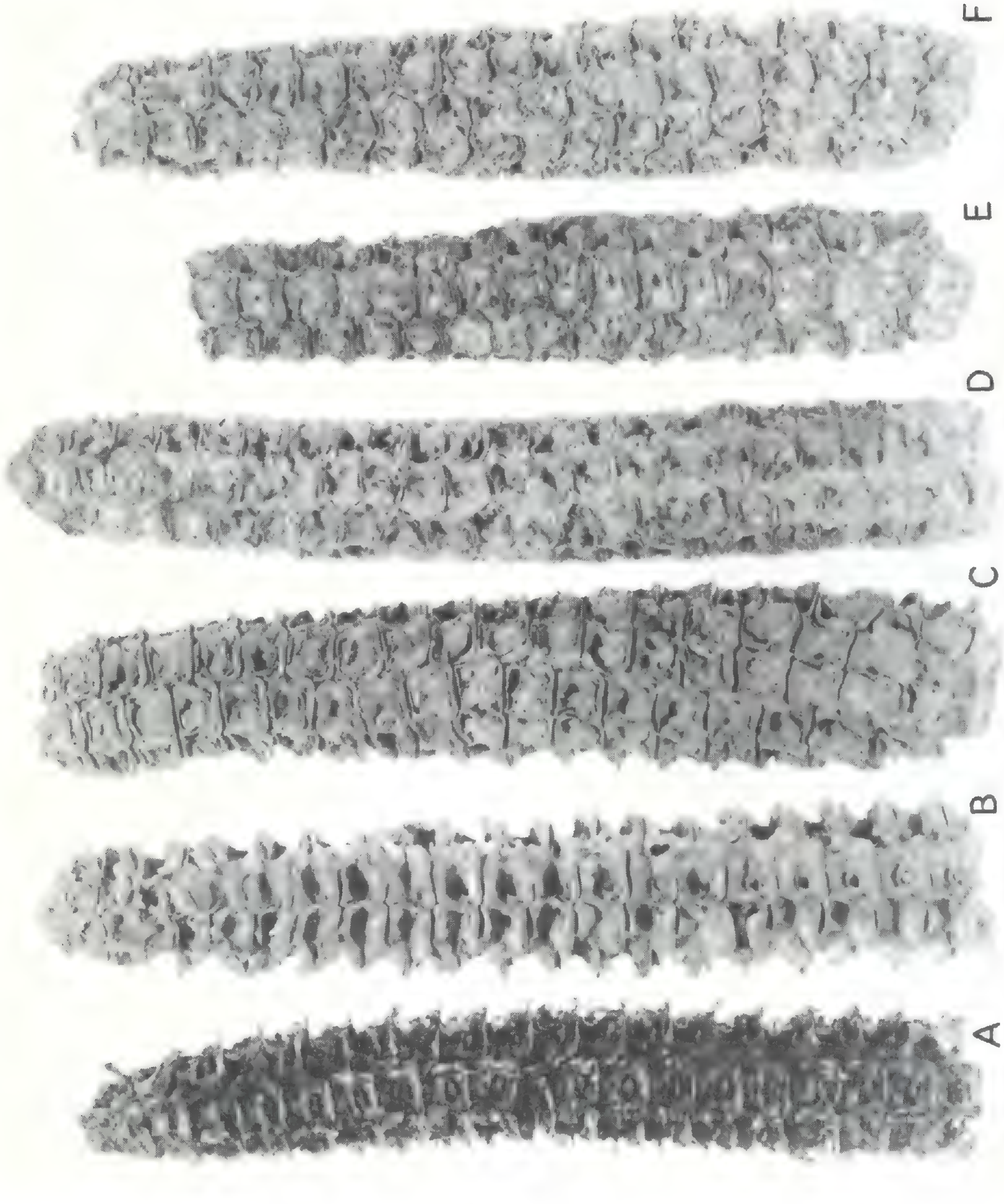
Plate XLI



EXPLANATION OF THE ILLUSTRATION

PLATE XLII. Cobs of an eight-rowed maize resembling the modern Mexican race, Harinoso de Ocho. A, An acid-eroded cob of modern Mandan Flour; B–E, Cobs from Swallow Cave, Structures 1 and 2; F, Cob from Slab Cave. Natural size.

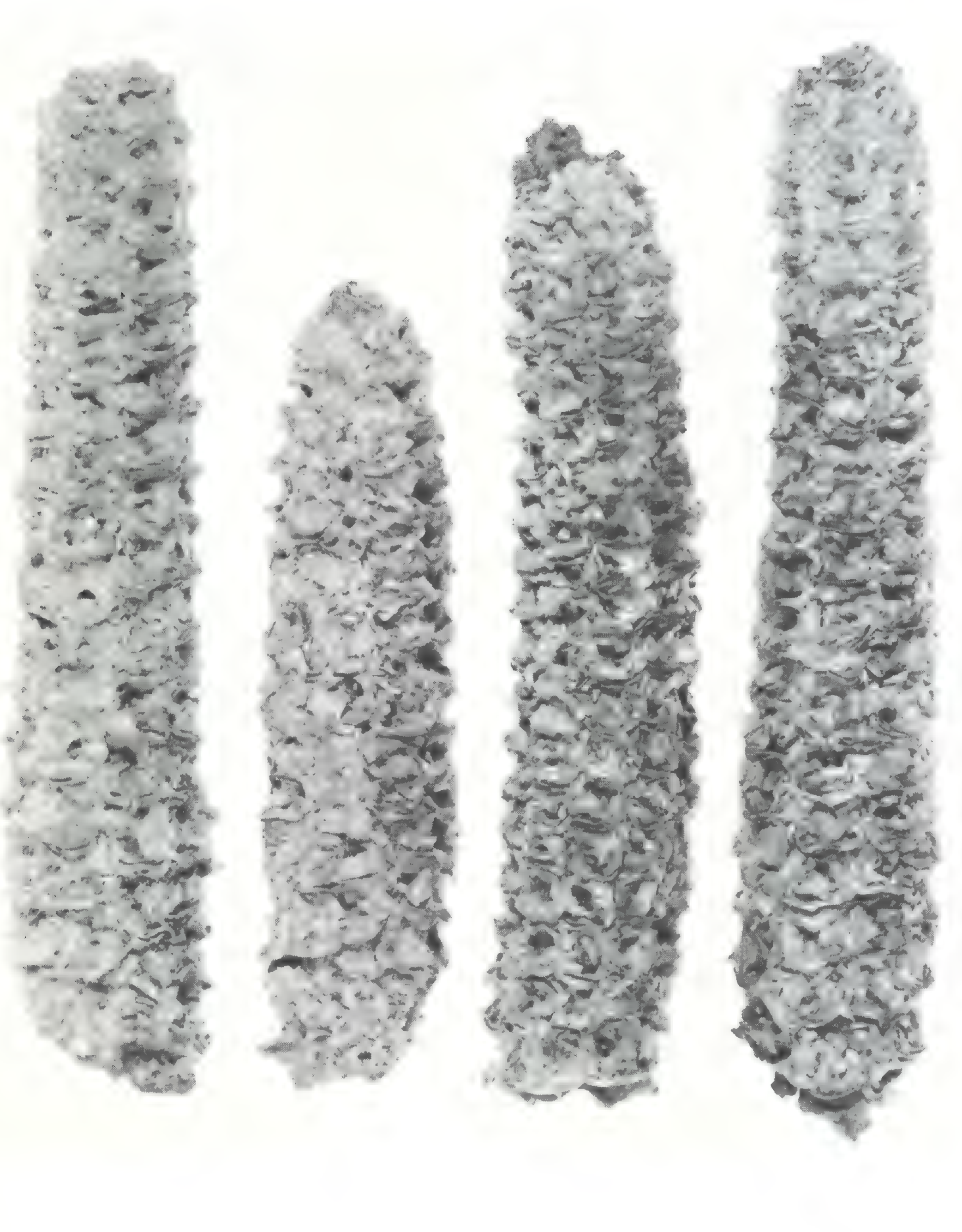
Plate XLII



EXPLANATION OF THE ILLUSTRATION

PLATE XLIII. Cobs from Swallow Cave, Structures 1 and 2, which resemble the cobs of a modern race in Chihuahua, Cristalino de Chihuahua. Natural size.

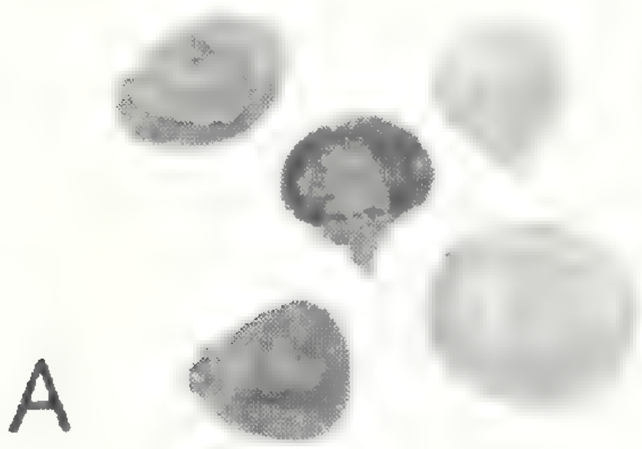
Plate XLIII



EXPLANATION OF THE ILLUSTRATION

PLATE XLIV. Kernels from several caves in northwestern Mexico. A, Dark Cave, Level 1; B, Olla Cave; C, Slab Cave; D, Tau Cave; E, Dark Cave, Level 6. Note one large kernel of an eight-rowed maize in A. Many of the kernels in B, C and D, resemble those of the modern Mexican race, Cristalino de Chihuahua. Natural size.

Plate XLIV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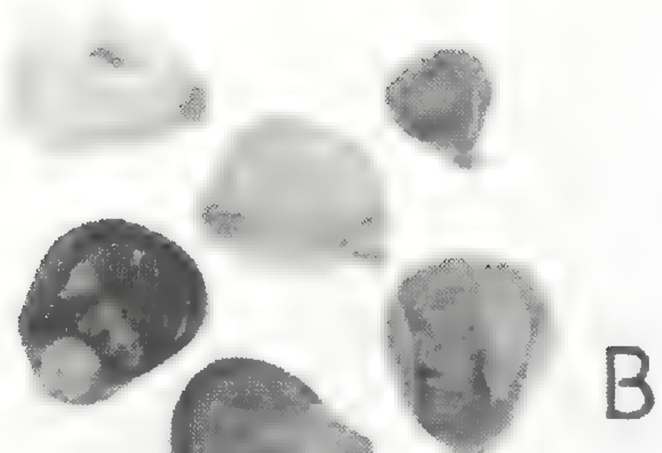
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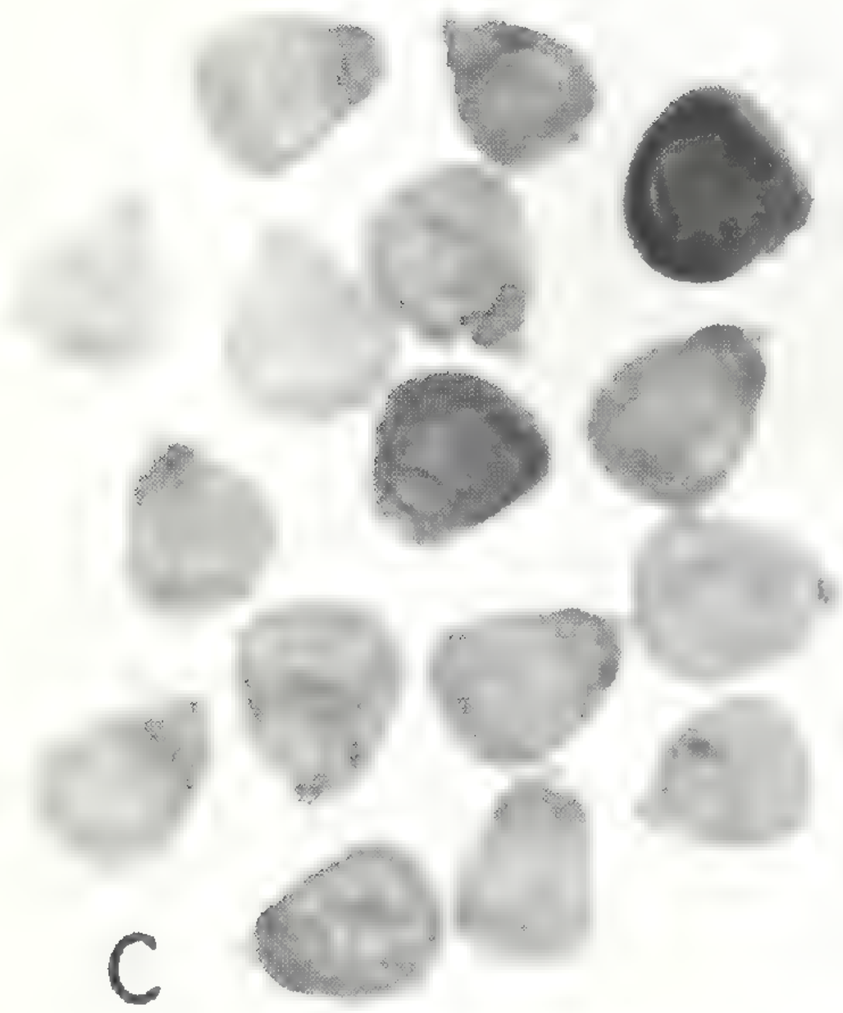
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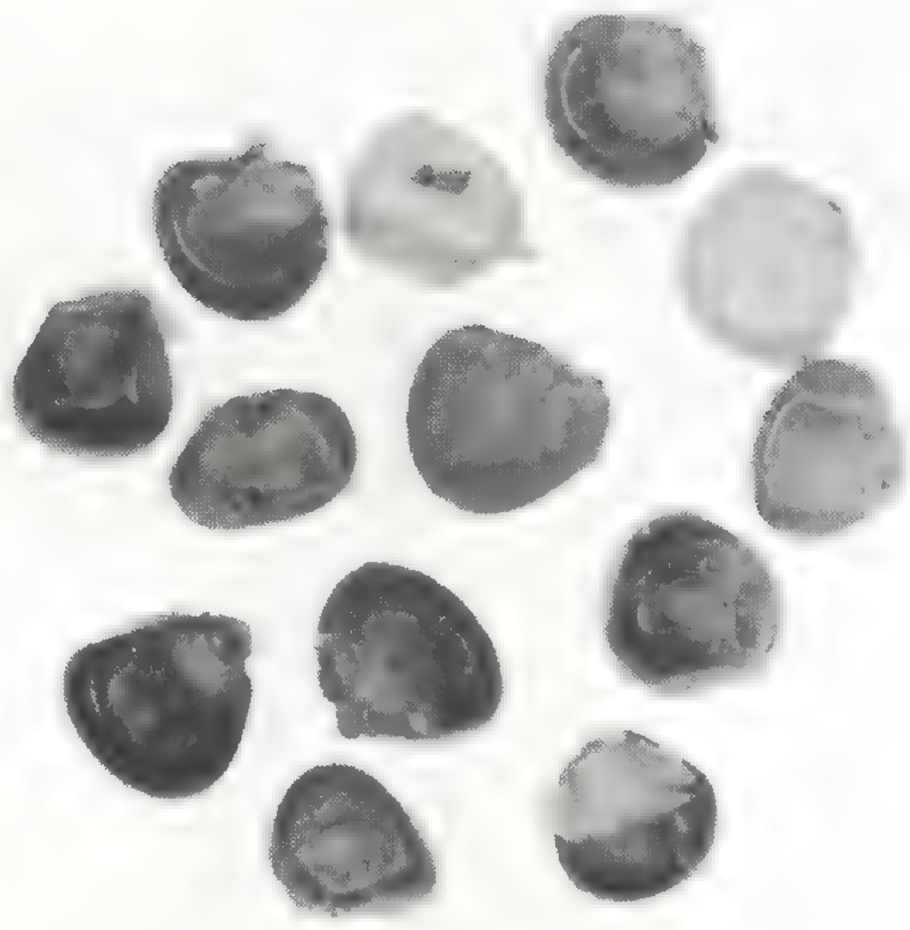
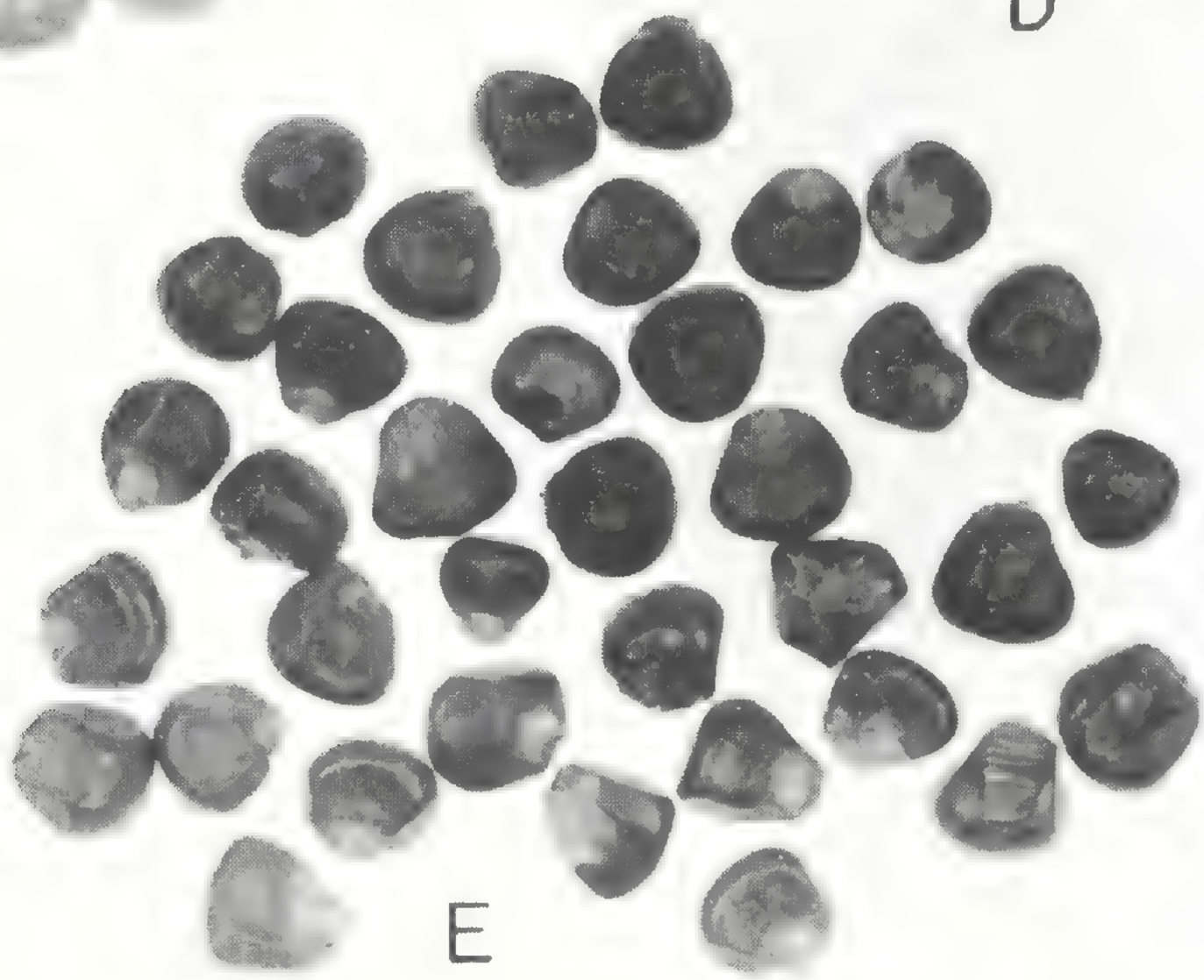
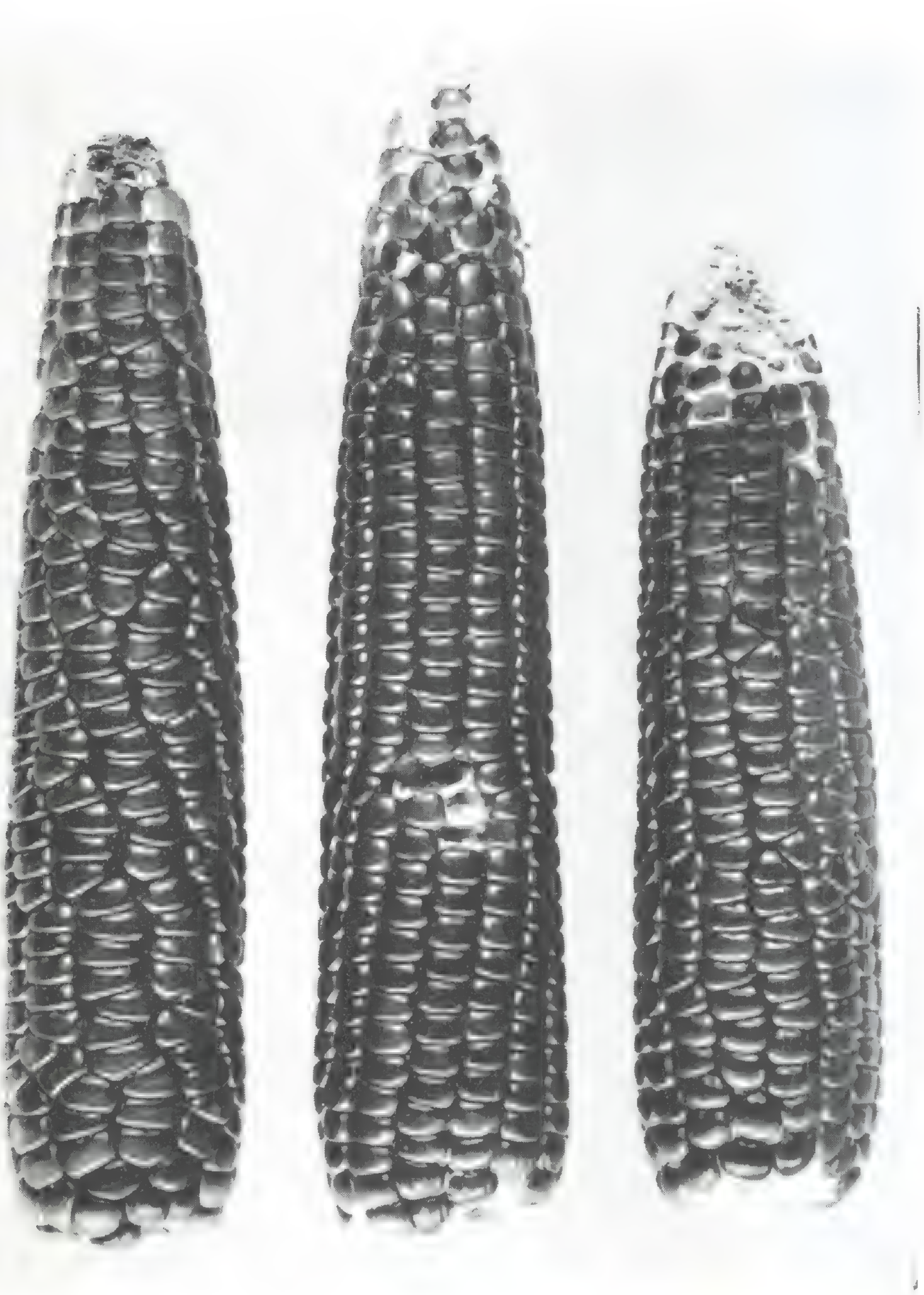

D


E

EXPLANATION OF THE ILLUSTRATION

PLATE XLV. Typical ears of Chapalote, a primitive race of pop corn found today in the states of Sinaloa and Sonora in northwestern Mexico. The ears are small, cigar-shaped and bear small flinty kernels with brown pericarp color. The majority of archaeological cobs described in this paper are related to this still-existing race. Scale 1 cm. = 1.17 cm. (From Wellhausen *et al*, 1952.)

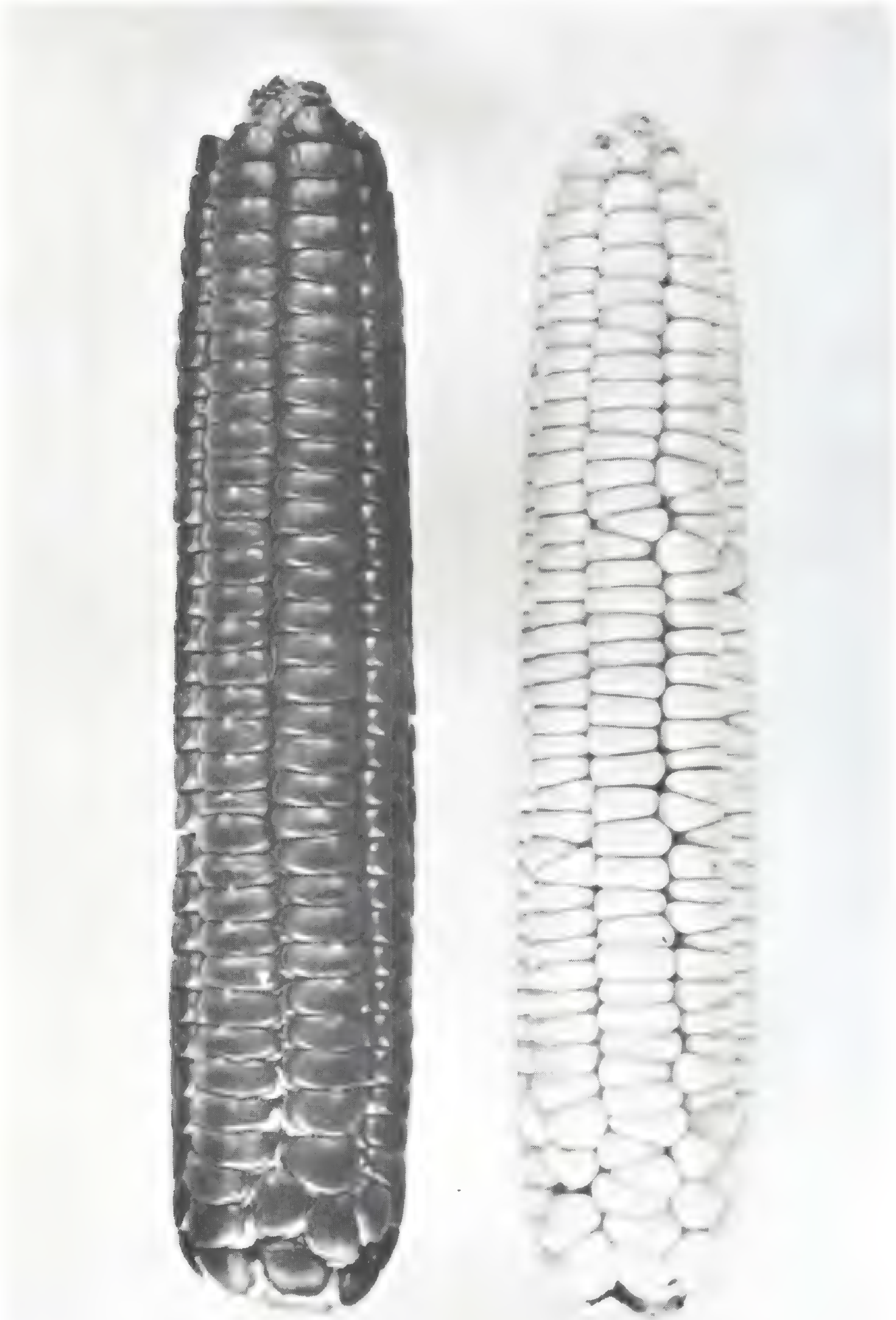
Plate XLV



EXPLANATION OF THE ILLUSTRATION

PLATE XLVI. Typical ears of Harinoso de Ocho, a race of flour corn still found occasionally in the states of Sinaloa and Sonora in northwestern Mexico. This race is believed to have originated in South America and to have been introduced into Mexico prehistorically. Archaeological cobs resembling those of this race were found in four of the caves described in this paper. Scale 1 cm. = 1.25 cm. (From Wellhausen *et al*, 1952.)

Plate XLVI



EXPLANATION OF THE ILLUSTRATION

PLATE XLVII. Typical ears of Cristalino de Chihuahua, a type of flint-dent corn occurring in the state of Chihuahua. This race is believed to be the product of three more or less independent lines of descent converging in northwestern Mexico: Chapalote, an ancient indigenous variety; Harinoso de Ocho, originally from South America; and introgression from teosinte. This race appears to have affinities with some of the modern maize of the American Southwest. Scale 1 cm. = 1.82 cm. (From Wellhausen *et al*, 1952.)

Plate XLVII

BOTANICAL MUSEUM LEAFLETS
HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, JUNE 26, 1956 VOL. 17, NO. 7

ORCHIDACEAE NEOTROPICALES I
DE ORCHIDACEIS INDIGENIS INSULARUM TRINIDAD ET TOBAGO NOTULAE

BY

RICHARD EVANS SCHULTES

THE following miscellaneous notes have accumulated during the preparation of a monograph on the orchids of Trinidad and Tobago.

Trinidad's place in orchid horticulture has been very important. This was especially so during the first half of the 19th Century. Some of the species mentioned below have been collectors' prizes. Others represent curious or little known "botanicals" of great interest to the taxonomist and phytogeographer.

There have been two comprehensive taxonomic treatments covering the orchids of Trinidad and Tobago. The earlier one is A. H. R. Grisebach's "Flora of the British West Indian Islands"; it was issued from 1859 to 1864 and enumerated 97 species of orchids from the Colony. In 1910, A. Cogniaux published a treatise on the orchids of the West Indies in volume six of Urban's "Symbolae Antillanae"; he recognized 148 species and a few varieties as native to Trinidad and Tobago.

Since 1910, the number of orchids known from Trinidad and Tobago has grown appreciably as a result of careful and persistent collecting. This is due in great part to the remarkable field work of the late Mr. Walter

E. Broadway (cf. Orch. Rev. 43 (1935) 354). In the 1920's, Broadway published in the *Orchid Review* a series of papers on his discoveries. Many of the rare species, found on the islands for the first time, or re-collected after a lapse of many years, were briefly discussed, and valuable ecological and cultural notes were included for some of the species. It is unfortunate that Broadway never cited herbarium specimens to authenticate his discoveries. The Orchid Herbarium of Oakes Ames, where most of Broadway's later collections were determined, counts itself fortunate in having a rather complete set of Broadway's material. A number of the Broadway collections which established new records in plant distribution, but which were not cited in Broadway's papers, are here enumerated for the first time.

Recently, Dr. Wilbur G. Downs and Dr. T. H. G. Aitken of the Trinidad Regional Virus Laboratory in Port-of-Spain have made extensive and discerning collections of native orchids. They have brought these collections into cultivation and have prepared a series of outstandingly excellent photographs of the living plants. Many represent species not hitherto illustrated. A complete set of these photographs is deposited in the Orchid Herbarium of Oakes Ames, where the corresponding specimens have been identified and are preserved.

For the purpose of easy reference for both collector and orchid lover who may not be familiar with any phylogenetic system of generic classification, the genera, and under them the species, are here arranged alphabetically. Specimens for this study have been available from the Trinidad Herbarium at the Imperial College of Tropical Agriculture, from the Royal Botanic Gardens, Kew, from the Orchid Herbarium of Oakes Ames of the Botanical Museum of Harvard University and from the Gray Herbarium of Harvard University. Several new

combinations are made herein and sundry names are reduced to synonymy.

For permission to publish the excellent photographs in this article, I am indebted to Dr. Downs. The drawings have been prepared by Mr. Elmer W. Smith.

Catasetum *L. C. Richard*

Catasetum barbatum (*Lindl.*) *Lindley* in Bot. Reg. 30 (1844) Misc. 38.

Myanthus barbatus Lindley in Bot. Reg. 31 (1835) t. 1778.

Known previously from the northern half of South America, *Catasetum barbatum* is now recorded from Trinidad on the basis of the collections cited below.

Trinidad: September [no year given], *Broadway s.n.* (Herb. Trin. 8750); Royal Botanic Gardens, September 1891, *Alexander s.n.* (Herb. Trin. 5431); September 19, 1914, *Nurse s.n.* (Herb. Trin. 8751); Siparia, April 14, 1916, *Broadway* (?) *s.n.* (Herb. Trin. s.n.); North Trace via Princes Town, August 19, 1918, *Broadway s.n.* (Herb. Trin. 8836, 8837); June 1925, *Hombersley s.n.* (Herb. Trin. 11846).

Catasetum cernuum (*Lindl.*) *Reichenbach fil.* in Walpers Ann. Bot. 6 (1863) 570.

This species has been cited from Trinidad by Cogniaux, but, as Mansfeld has pointed out (in Fedde Repert. Sp. Nov. 31 (1932) 109), it does not occur naturally in Trinidad. The specimens in the Trinidad Herbarium (Nos. 8836, 8837) which have been identified as *Catasetum cernuum* are small forms of *C. barbatum*.

Cattleya *Lindley*

Cattleya Deckeri *Klotzsch* Allgem. Gartenz. 23 (1855) 81.

This species was cited from Trinidad by Cogniaux through a *Bradford* and a *Crueger* collection. We now have available several additional collections. The species

is widespread from Mexico throughout Middle America and the West Indies and possibly in northern South America.

TRINIDAD: Gasparillo Road, Santa Cruz Valley, February 1, 1926, *Freeman s.n.* (Herb. Trin. 11506); Santa Cruz, January 22, 1927, *Williams s.n.* (Herb. Trin. 11718; Herb. Ames 68193).

CORYANTHES *Hooker*

Coryanthes macrantha (*Hook.*) *Hooker* in Bot. Mag. (1831) t. 3102.

Gongora macrantha Hooker Bot. Misc. 2 (1831) 151.

This species, called "monkey orchid" in Trinidad, was cited by Cogniaux through a cultivated specimen. Although we now have a number of additional collections from Trinidad, all are from gardens, and we are still not certain as to whether or not this orchid, known from Venezuela and British Guiana, may be an indigenous species on the island.

TRINIDAD: Botanic Gardens (Herb. Trin. 4585); June 1896 (Herb. Trin. s.n.); St. Clair Experimental Station, April 12, 1907, *Broadway s.n.* (Herb. Ames 10220); St. Clair Experimental Station, April 23, 1908, *Broadway s.n.* (Herb. Ames 10714); St. Clair Experimental Station, May 18, 1908, *Broadway s.n.* (Herb. Ames 10652); July 7, 1908, *Broadway s.n.* (Herb. Ames 11676); St. Mary's College, 1927, *Graff s.n.* (Herb. Trin. s.n.).

CYRTOPODIUM *R. Brown*

Cyrtopodium Andersonii (*Lamb. ex Andrews*) *R. Brown* in Aiton Hort. Kew, ed. 2, 5 (1813) 216.

Cymbidium Andersonii Lambert ex Andrews Bot. Repos. 10 (1811) 651.

Cyrtopodium Andersonii may not occur naturally in Trinidad. Both Hart and Lockhart were wont to gather material from cultivated sources, and it is very possible that the two collections cited below are from cultivation.

When Broadway (in Orch. Rev. 34 (1926) 133) re-

ported *Cyrtopodium Andersonii* from the Bocas Islands, he was referring to *C. punctatum*. He stated that he was giving the "specific name with some hesitation." All of the Trinidad collections of *Cyrtopodium punctatum* are from Chacachacare, one of the Bocas Islands (*vide sub C. punctata*).

TRINIDAD: *Hart s.n.* (Herb. Trin. 1817): *Lockhart s.n.* (cited by Cogniaux).

Cyrtopodium Broadwayi *Ames* Orchid. 7 (1922) 51, t. 112.

Broadway (loc. cit. 133) reported *Cyrtopodium Broadwayi* as "fairly plentiful." The wealth of material cited below indeed stresses the abundance of the species at Aripo Savannah. This species is apparently endemic to Trinidad. It has been confused with *Cyrtopodium cristatum* Lindl. of northern South America.

TRINIDAD: Aripo Savannah (Herb. Trin. s.n.); Piarco Savannah, *Lunt s.n.* (Herb. Trin. 6021); Aripo Savannah, *Hart. s.n.* (Herb. Trin. 5326); Caroni Savannah, 1888, *Hart. s.n.* (Herb. Trin. 3499); Botanic Gardens, February 27, 1893, *Hart s.n.* (Herb. Trin. 5261); Aripo Savannah, March 26, 1893, *Broadway s.n.* (Herb. Trin. 5326); April, 1896, *Alexander* (?) *s.n.* (Herb. Trin. s.n.); Aripo Savannah, April 16, 1908, *Broadway 2343* (TYPE, Herb. Ames 11713), Aripo Savannah, August 19, 1908, *Broadway 2343a* (Herb. Trin. s.n.); July 28, 1909, *Broadway 2343b* (Herb. Ames 11712); Aripo Savannah, February 13, 1915, *Freeman s.n.* (Herb. Trin. 8044; Herb. Ames 66997); Aripo Savannah, March 5, 1920, *Britton, Broadway & Hazen 313* (Herb. Trin. 10526); February–March 1921, *Bailey & Bailey T40* (Herb. Ames 20553); Aripo Savannah, January 31, 1922, *Broadway s.n.* (Herb. Trin. 10498): near Mount Tamana, Mount Harris, February 2, 1922, *Nowell s.n.* (Herb. Trin. 10502); Aripo Savannah, April 2, 1953, *Baker & Simmonds s.n.* (Herb. Trin. 14921).

Cyrtopodium punctatum (*L.*) *Lindley* Gen. & Sp. Orch. (1833) 188.

Epidendrum punctatum L. Syst. ed. 10 (1759) 1246.

Cyrtopodium punctatum in Trinidad has been confused with *C. Andersonii* (*q. vide*). Cogniaux reported it from

Trinidad on the basis of one collection: *Othmer 121*. It appears to be not infrequent at Chacachacare, as shown by the material cited below.

TRINIDAD: Chacachacare, April 18, 1865 (Herb. Trin. 1972); May 23, 1908, *Evans s.n.* (Herb. Ames 10683, 10684, 10685); Chacachacare, May 18, 1916, *Doyle s.n.* (Herb. Trin. 8121); Chacachacare, May 1925, *Williams s.n.* (Herb. Trin. 11059).

DIACRIUM *Bentham*

Diacrium indivisum (*Bradf.*) *Broadway* in Bull. Misc. Inform. Trinid. 2 (1895) 79.

Epidendrum indivisum Bradford in Grisebach Fl. Br. W. Ind. Isl. (1864) 614.

Diacrium bicornutum (Hook.) Bentham var. *indivisum* (Bradf.) Cogniaux in Martius Fl. Bras. 3, pt. 5 (1898) 188.

There has been some difference of opinion as to whether this concept should be treated as a variety of *Diacrium bicornutum* or as a distinct species. There seems to be sufficient morphological evidence to maintain it as distinct, and the extreme difference in choice of habitat of *Diacrium bicornutum* and *D. indivisum* would seem to support such a disposition. After studying living material with perfect flowers, Rolfe (in Orch. Rev. 11 (1903) 187) presented the evidence for maintaining the two concepts as distinct. Cogniaux, nevertheless, preferred the varietal treatment.

Cogniaux cited one collection — the type — from Trinidad. Apparently an endemic, *Diacrium indivisum* is now known from a number of localities on the island.

It will be of interest here to quote the field notes of the experienced orchid-collector, Mr. Broadway (in Orch. Rev. 34 (1926) 131), concerning the habitats of these two orchids: "*Diacrium bicornutum*. Along wind-swept sea-coast districts is the real home of *D. bicornutum* Benth.,

the 'Virgin Orchid.' It grows upon rocks, as on some of the Bocas islands, and certain of the coastal parts of the colony, or established in the higher boughs of tall trees, as along the southern coast of Ananzanilla [Manzanilla]. It is never, to my knowledge, found inland. Frequently, the older plants grow into large clumps, and, seated upon either rock or tree, are observed to be in the full blast of sea spray, and high, strong winds, which oftentimes become gales of violence. The pseudobulbs are long and bulging, being hollow inside and forming the abode of ants, usually.

"*Diacrium bicornutum* var. *indivisum*. Contrary to the habits of the preceding plant, there is another which likes the inland districts of the colony, and presumably it is never found close to the sea. . . . It is of smaller proportions altogether, but the most unobservant would recognize the similarity to its relatives. . . . The whole plant only assumes small clump proportions at its maximum development."

TRINIDAD: "Inland Districts" (Herb. Trin. 5512); "Inland woods" (Herb. Trin. 5983); Savannah near Government House, June 3, 1907, *Broadway s.n.* (Herb. Ames 10736); "Savanna. . . . near Government House Grounds," June 22, 1907, *Broadway s.n.* (Herb. Ames 10727); Erin, March 27, 1908, *Broadway s.n.* (Herb. Ames 10640): River Estate, February 18, 1926 (Herb. Trin. 11518); St. Augustine, April 25, 1949, *Simmonds 351* (Herb. Trin. 14338; Herb. Ames 66931).

DICHAEA *Lindley*

Dichaea graminoides (*Sw.*) *Lindley* Gen. & Sp. Orch. Pl. (1833) 209.

I have seen no material from Trinidad or Tobago which can be referred with certainty to *Dichaea graminoides*. It is clear from an examination of several collections at Kew, which Cogniaux cited from Trinidad as *Dichaea graminoides* (but which actually represent *D. picta*), that there was some confusion in his treatment of this species.

I have not seen *Broadway 3119* from Tobago, which Cogniaux ascribed to *D. graminoides*.

Dichaea hystricina *Reichenbach fil.* Flora 48 (1865) 279.

Known from Cuba, Guadeloupe, Dominica, Grenada and Middle America, *Dichaea hystricina* has not hitherto been reported from Trinidad with the citation of authenticating material.

TRINIDAD: Oropouche, April 1896, *Alexander s.n.* (Herb. Trin. 6096).

Dichaea muricata (*Sw.*) *Lindley* Gen. & Sp. Orch. Pl. (1833) 209.

Cymbidium muricatum Swartz in Nov. Act. Upsal. 6 (1796) 71; Fl. Ind. Occ. 3 (1799) 1454.

Common in most of the West Indies, Middle America and northern South America, *Dichaea muricata* apparently has not hitherto been cited, on the basis of specimens, from Trinidad or Tobago.

TRINIDAD: Heights of Aripo, January 10–26, 1922, *Broadway s.n.* (Herb. Trin. 9887); Nestor Village, February 12, 1955, *Downs & Aitken 22* (Herb. Ames 67322).

Dichaea picta *Reichenbach fil.* in Saunders Ref. Bot. 2 (1870) t. 84.

Dichaea picta was not cited by Cogniaux from Trinidad and Tobago.

TRINIDAD: (Herb. Trin. 405); *Crueger s.n.* (Herb. Kew); February 1846, *Bradford s.n.* (Herb. Kew); November 7, 1881, *Fendler 782* (Herb. Kew); Maraval, February 4, 1911, *Broadway 4131* (Herb. Kew); Aripo Savannah, February 13, 1915, *Freeman s.n.* (Herb. Trin. 8048); September 3, 1919, *Broadway s.n.* (Herb. N.Y. Bot. Gard.); El Tucuche, January 17, 1924, *Hill, Williams et al s.n.* (Herb. Trin. 10705); Maraval, January 14, 1926, *Broadway 6270* (Herb. Kew); Maraval, March 1926, *Broadway s.n.* (Herb. Kew); Caroni, April 30, 1925, *Freeman, Williams et al s.n.* (Herb. Trin. 11021); Saut d'Eau, north coast, December 14, 1930, *Broadway 7438* (Herb. Ames 37199).

Dichaea Rendlei *Gleason* in Bull. Torr. Bot. Club 54 (1927) 604.

Dichaea Rendlei is known from British Guiana, Guadeloupe and Trinidad. The two Trinidad collections differ from the type in having a rounded, instead of a subacute, anchoraeform lip, but, in other characters, they can easily be accommodated within the concept.

TRINIDAD: Aripo, April 16, 1908, *Broadway 2330* (Herb. Ames 10668); Mora Forest, September 3, 1925, *Williams s.n.* (Herb. Trin. 11347; Herb. Ames 66928).

Inasmuch as Cogniaux cited but one species of *Dichaea* from Trinidad, it may be helpful to have the following key to distinguish the concepts now recognized from the Colony.

1. Leaves not articulate, persistent.
   2. Leaves relatively large, distant (0.8–1 cm. or more apart) glabrous; margins entire. *Dichaea muricata*
   2A. Leaves very small, close (less than 4 mm. apart), echinulate on both surfaces; margins denticulate-ciliate. *Dichaea hystricina*

1A. Leaves articulate at base, deciduous.
   3. Leaves narrowly linear. Petals lanceolate. Lip conspicuously keeled. *Dichaea graminoides*
   3A. Leaves oblong-ligulate. Petals ovate or oblong. Lip without keel.
      4. Leaves apiculate. Lateral sepals ovate, 5–5.5 mm. long. Petals 4 mm. long. Lip anchor-shaped, lateral lobes linear. *Dichaea Rendlei*
      4A. Leaves not apiculate. Lateral sepals broadly lanceolate, 7–8 mm. long. Petals 7–8 mm. long. Lip triangular-sagittate; lateral lobes triangular-falcate. *Dichaea picta*

EPIDENDRUM *Linnaeus*

Epidendrum anceps *Jacquin* Sel. Stirp. Amer. (1763) 224, t. 138.

Collections of this common and wide-ranging orchid have apparently not hitherto been cited from Trinidad and Tobago.

TRINIDAD: Heights of Aripo, January 10–26, 1922, *Broadway s.n.* (Herb. Trin. 9902); Saut d'Eau, March 8, 1931, *Broadway 7501* (Herb. Ames 37540).

Epidendrum Bradfordii *Griseb.* Fl. Br. W. Ind. Isl. (1864) 613.

The collection cited below represents an individual, probably of this species, with peloric flowers. *Epidendrum Bradfordii*, known hitherto only from the type collected by Bradford at Arima, is apparently a rare endemic.

TRINIDAD: Aripo, April 16, 1908, *Broadway 2334* (Herb. Ames 10662).

Epidendrum cristatum *Ruíz & Pavón* Syst. Veg. (1798) 243.

Epidendrum raniferum Lindley Gen. & Sp. Orch. Pl. (1831) 109.

Epidendrum raniferum Lindley var. *luteum* Lindley Fol. Orch. Epidendrum (1853) 53.

Epidendrum cristatum has apparently not hitherto been cited from Trinidad, except for the collection *Hart 3669* which was reported as *E. raniferum* var. *luteum*.

It would seem that the characters upon which Lindley based his varietal concept *luteum* are neither fundamental nor stable. The lip and the coloration of the flower are very variable in *Epidendrum cristatum*, and since the variety was based on color and lip characters, I am reducing it to synonymy under *Epidendrum cristatum*.

A complete synonymy of *Epidendrum cristatum* is given in Ames, Hubbard and Schweinfurth "The genus Epidendrum in the United States and Middle America" (1936) 166 and by Schweinfurth in Bot. Mus. Leafl. Harvard Univ. 11 (1944) 222.

TRINIDAD: July 29, 1865 (Herb. Trin. 1975); Botanic Gardens, 1888, *Broadway s.n.* (Herb. Trin. 3669); Cedros, December 1889,

Alexander s.n. (Herb. Trin. 4992); Maraval, 1894, *Baptiste s.n.* (Herb. Trin. 5490); March 5, 1921, *Broadway s.n.* (Herb. Trin. 10500); Botanic Gardens, February 15, 1933, *Bruins-Lich s.n.* (Herb. Trin. 12752); *Hart 3669* (cited by Cogniaux).

Epidendrum Hartii *Rolfe* in Kew Bull. (1894) 157.

Cogniaux enumerated five collections of this beautiful *Epidendrum* from Trinidad and Tobago, and reported it as frequent in Trinidad. The truth of this statement is shown by the large number of collections (in addition to those cited by Cogniaux) from the island.

Epidendrum Hartii, once thought to be endemic to Trinidad and Tobago, has recently been found in Venezuela in the Estado de Anzoátegui: between Río León of Quebrada Danta and Río Zumbador, northeast of Bergantín, 500–600 m., February 24, 1945, *Steyermark 61125* (Herb. Ames 64919).

TRINIDAD: Heights of Maraval, *Broadway s.n.* (Herb. Ames 16555); February 25, 1889, *Broadway s.n.* (Herb. Trin. 3552); April 22, 1890, *Broadway s.n.* (Herb. Trin. 4023); Maraval, April 1894, *Alexander s.n.* (Herb. Trin. 5460; Herb. Ames 66940); Government House Grounds, February 25, 1907, *Broadway s.n.* (Herb. Ames 10067, 10068, 10069); St. Clair Experiment Station, January 6, 1908, *Broadway s.n.* (Herb. Ames 10717, 10718, 10719); March 22, 1920, *Broadway s.n.* (Herb. Ames 22019); Maracas Falls, March 27, 1924, *Hombersley s.n.* (Herb. Trin. 11202); Arena Forest Reserve, 1948, *Ayliffe s.n.* (Herb. Trin. 14261); Mt. Tucuche, alt. 1500 ft., February 28, 1954, *Baker s.n.* (Herb. Trin. 15112; Herb. Ames 66943); St. Patrick's Estate, Arima, March 8, 1955, *Downs & Aitken 30* (Herb. Ames 67832.

Epidendrum imatophyllum *Lindley* Gen. & Sp. Orch. Pl. (1831) 106.

Epidendrum flexuosum G. F. W. Meyer Prim. Fl. Esseq. (1818) 260.

This widely ranging species seems not to have been reported from Trinidad. The name *Epidendrum flexuosum* refers probably to the same concept, but the original description is too vague to permit the adoption of the

binomial (Ames, Hubbard and Schweinfurth: loc. cit. 107).

TRINIDAD: Cunupia, March 23, 1892, *Alexander s.n.* (Herb. Ames 7451); St. Ann's (Cascade), March 6, 1894, *Hart s.n.* (Herb. Trin. 5481); St. Clair Experiment Station, April 16, 1907, *Broadway s.n.* (Herb. Ames 10205, 10206, 10207).

Epidendrum laxum *Poeppig & Endlicher* Nov. Gen. ac Sp. 2 (1838) 2.

Epidendrum yatapuense Barbosa-Rodrígues in Vellosia 1, ed. 2 (1891) 123.

Epidendrum macrothyrsis Lehmann & Kränzlin in Engler Bot. Jahrb. 26 (1899) 472.

An examination of the type of *Epidendrum laxum*, which is preserved in the Vienna herbarium, shows that it represents the same concept which has been called *E. yatapuense* and *E. macrothyrsis*. There is rather appreciable variability in the size and luxuriance of the plants. The type is a large specimen with a long inflorescence, whereas the Trinidad material represents small individuals. In critical characters, however, there is little variation in the material gathered over the range of the species: Trinidad, Peru, Ecuador, Amazonian Brazil and British Guiana.

The reduction of *Epidendrum yatapuense* to synonymy under *E. laxum* is based on a study of: 1) the original description of this concept and Cogniaux's amplified description in Martius' *Flora Brasiliensis;* and 2) the original Barbosa-Rodrígues painting of *E. yatapuense*, preserved in the library of the Orchid Herbarium of Oakes Ames, and the drawing (based on the original painting in *Flora Brasiliensis*). There is no doubt that *Epidendrum yatapuense* is referable to *E. laxum*.

TRINIDAD: November 1, 1865, *Prestoe s.n.* (Herb. Trin. s.n.); Maraval, November 17, 1934, *Sylvester s.n.* (Herb. Trin. 13073).

Epidendrum moyobambae *Kränzlin* in Fedde Repert. Sp. Nov. 1 (1905) 185.

The Trinidad material which I studied (and which has always erroneously been referred to *Epidendrum patens*) cannot be distinguished from the Kränzlin concept *E. moyobambae*. Some of the Trinidad specimens are somewhat larger than material from South America.

Cogniaux cited a *Purdie* collection from Trinidad as *Epidendrum patens*, but I have not been able to examine it. In view of the homogeneity of the specimens cited below, it is probable that the *Purdie* collection is likewise referable to *Epidendrum moyobambae*. These two concepts may prove to be the same, but *Epidendrum patens* was described as having a paniculate inflorescence, whereas *E. moyobambae*, with its unbranched raceme, agrees with the Trinidad material.

The common name of *Epidendrum moyobambae* in Trinidad is reported to be "lamb's tail."

Trinidad: (Herb. Trin. 888); (Herb. Trin. 5581); Botanic Gardens, April 1887, *Hart s.n.* (Herb. Trin. 3680); St. Clair Experiment Station, April 12, 1908, *Broadway s.n.* (Herb. Ames 10710); Caparo, April 27, 1908, *Broadway s.n.* (Herb. Ames 11711); Cedros, May 10, 1918, *Sankerali s.n.* (Herb. Trin. 8747); Hindustani Road, via Princes Town, August 20, 1918, *Broadway s.n.* (Herb. Trin. 8820); base of Mount Tamana, April 18, 1920, *Britton, Britton & Hazen 1961* (Herb. Ames 20367); Moruga Road, Rock Forests, May 17, 1922, *Webbe s.n.* (Herb. Trin. 10137); Tamana, April 15, 1925, *Freeman s.n.* (Herb. Trin. 11199); April 17, 1929, *Murray s.n.* (Herb. Trin. 12128); St. Ann's, April 22, 1934, *Broadway s.n.* (Herb. Ames 40388); Caura Valley, May 7, 1949, *Wilson s.n.* (Herb. Trin. 14318; Herb. Ames 66933); Mount Tamana, alt. 1000 ft., June 1954, *Piening s.n.* (Herb. Trin. 15269; Herb. Ames 66927).

Epidendrum nocturnum *Jacquin* var. **minus** *Cogniaux* in Bull. Soc. Roy. Bot. Belg. 43 (1906) 323.

This variety, hitherto known only from northern South America, is now reported from Trinidad on the basis of the two collections cited below.

TRINIDAD: Aripo Savannah, February 13, 1915, *Freeman s.n.* (Herb. Trin. 8042); Aripo District, March 21, 1922, *Broadway s.n.* (Herb. Trin. 10562).

Epidendrum oncidioides *Lindley* var. **gravidum** (*Lindl.*) *Ames, Hubbard & Schweinfurth* in Bot. Mus. Leafl. Harvard Univ. 3 (1935) 104.

This concept has apparently not been previously cited as occurring in Trinidad. Its known range now includes Mexico, Middle America, Cuba, Puerto Rico, Trinidad, Colombia and Peru. A complete synonymy is presented by Ames, Hubbard & Schweinfurth (loc. cit.).

TRINIDAD: Botanic Garden, 1891, *Hart s.n.* (Herb. Trin. 5810); Botanic Garden, 1894, *Hart s.n.* (Herb. Trin. 5472); February 22, 1927, *Freeman s.n.* (Herb. Trin. 11719); February 2, 1931, *Broadway s.n.* (Herb. Ames 66922); Melajo Reserve, January 1949, *Ayliffe s.n.* (Herb. Trin. 14411).

Epidendrum Rousseauae *Schlechter* in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 407.

Epidendrum Rousseauae is new to the flora of Trinidad. It has hitherto been known only from Panama.

TRINIDAD: Morne Bleu, April 9, 1955, *Downs & Aitken 46* (Herb. Ames 67837).

Epidendrum vincentinum *Lindley* in Hooker Journ. Bot. 3 (1841) 88.

Known previously from Costa Rica, Colombia and Peru, and many of the West Indian islands, *Epidendrum vincentinum* seems not to have been reported from Trinidad with the citation of botanical material.

TRINIDAD: Heights of Aripo, January 10–26, 1922, *Broadway s.n.* (Herb. Trin. 9905).

ERYTHRODES *Blume*

Erythrodes hirtella (*Sw.*) *Fawcett & Rendle* Fl. Jam. 1 (1910) 29, t. 3, figs. 16–19.

Satyrium hirtellum Swartz Prodr. (1788) 118.

This species seems not to have been reported from Trinidad or Tobago by Cogniaux.

TRINIDAD: St. Ann's, April 30, 1848 (Herb. Trin. 409); December 23, 1892, *Alexander s.n.* (Herb. Trin. 5075); Tucuche, February 27, 1893, *Broadway s.n.* (Herb. Trin. 5248).

Erythrodes trinitatis *Ames* Orch. 7 (1922) 76.

Erythrodes trinitatis has apparently been collected but once.

TRINIDAD: St. Ann's, 1888, *Broadway s.n.* (Herb. Ames 68183: drawings of TYPE).

HABENARIA *Willdenow*

Habenaria alata *Hooker* Exot. Fl. 3 (1827) t. 169.

Habenaria alata was not cited from the Colony by Cogniaux, nor have I seen specimens from the island of Trinidad.

TOBAGO: Montpelier, near Scarborough, October 3, 1909, *Broadway 3051* (Herb. Ames 11726, 11727, 26456; Herb. Gray 88); November 1914, *Sworder s.n.* (Herb. Trin. s.n.); near Mason Hall, Courland River Valley, October 19, 1937, *Sandwith 1858* (Herb. Ames 64123).

Habenaria Leprieurii *Reichenbach fil.* var. **heptadactyla** (*Reichb.f.*) *R. E. Schultes comb. nov.*

Habenaria heptadactyla Reichenbach fil. in Schomburgk Fauna & Fl. Guian. (1848) 1123, *nomen;* in Linnaea 22 (1849) 812.

There appear to be no appreciable structural differences in the flowers of *Habenaria Leprieurii* (*H. mesodactyla* Grisebach) and *H. heptadactyla*. In the latter, there are usually more flowers than in the former, and the flowers are congested at the very tip of the inflorescence, instead of being placed more or less loosely and distantly along the upper third of the inflorescence. It seems desirable to reduce *H. heptadactyla* to varietal status.

Habenaria Leprieurii var. *heptadactyla* occurs in Panama, Colombia, Venezuela, British Guiana, Amazonian Brazil and Trinidad.

Trinidad: Aripo, July 7–8, 1848 (Herb. Trin. 884); Aripo Savannah, April 16, 1908, *Broadway 2337* (Herb. Ames 10679); Aripo Savannah, February 13, 1915, *Freeman s.n.* (Herb. Trin. 8775); Aripo Savannah, August 16, 1922, *Broadway s.n.* (Herb. Trin. 10181); Aripo Savannah, August 7, 1925, *Williams & Freeman s.n.* (Herb. Trin. 11320; Herb. Gray 7745); Aripo Savannah, August 1934, *Wright s.n.* (Herb. Trin. s.n.); Aripo Savannah, July 27, 1943, *Beard 142* (Herb. Ames 62755); *Broadway 2903* (Herb. Ames 14579).

Habenaria monorrhiza (*Sw.*) *Reichenbach fil.* in Ber. Deut. Bot. Ges. 3 (1885) 274.

Orchis monorrhiza Swartz Prodr. (1788) 118.

One of the most common species of *Habenaria* in the West Indies, Middle America and northern South America, *H. monorrhiza* was not cited from Trinidad and Tobago by Cogniaux.

Tobago: Concordia, December 23, 1908, *Broadway 2426*, (Herb. Ames 11732, 11733); Indian Walk, January 5, 1910, *Broadway s.n.* (Herb. Ames 26464; Herb. Gray 100); Concordia, January 24, 1910; *Broadway s.n.* (Herb. Ames 16548); Adelphi, January 24, 1913, *Broadway s.n.* (Herb. Gray 99).

Trinidad: (Herb. Trin. 1965); June 8, 1865 (Herb. Trin. 1966); Oropouche, 1888, *Murray s.n.* (Herb. Trin. 3551); Santa Cruz, January 1890, *Broadway s.n.* (Herb. Trin. s.n.; Herb. Ames 68175); Belmont, St. Francis Valley Road, December 22, 1906, *Broadway s.n.* (Herb. Ames 10597, 10098, 10099, 62717); Chancellor Road, December 24, 1924, *Freeman s.n.* (Herb. Trin. s.n.); North Coast Road to Maracas Bay, January 27, 1952, *Baker s.n.* (Herb. Trin. 14725).

Habenaria pauciflora (*Lindl.*) *Reichenbach fil.* in Bonplandia 2 (1854) 10.

Bonatea pauciflora Lindley Gen. & Sp. Orch. Pl. (1835) 329.

Habenaria pauciflora, a widespread species throughout tropical America, has apparently been collected but once on the island of Trinidad.

Trinidad: St. Joseph Savannah, August 31, 1925, *Withycombe s.n.* (Herb. Trin. 11336).

Habenaria repens *Nuttall* Gen. N. Am. Pl. 2 (1818) 190.

An unusually widespread species in tropical and subtropical America, *Habenaria repens*, which normally grows in shallow water, was not cited from Trinidad by Cogniaux. Known from the island by but two collections, it would appear not to be common.

Trinidad: Los Bajos, June 6, 1925, *Williams s.n.* (Herb. Trin. 11180; Herb. Ames 67786); Cedros, *Broadway s.n.* (Herb. Trin. 9770).

Ionopsis *Humboldt, Bonpland & Kunth*

Ionopsis pygmaea *Cogniaux* in Urban Symb. Antill. 6 (1910) 624.

This extraordinary little species of *Ionopsis*, known only from the type collection and apparently endemic to Trinidad, has never been figured. It has seemed advisable to publish the accompanying drawing made from the duplicate type in the Orchid Herbarium of Oakes Ames.

Trinidad: Caparo, March 17, 1908, *Broadway 2251* (Herb. Ames 10644).

Ionopsis utricularioides (*Sw.*) *Lindley* Coll. Bot. (1825) t. 39a.

Epidendrum utricularioides Swartz Prodr. (1788) 122.
Iantha pallidiflora Hooker Exot. Fl. 2 (1825) t. 113.
Ionopsis pallidiflora (Hook.) Lindley loc. cit. sub. t. 1904.

Cogniaux has maintained *Ionopsis pallidiflora* as a distinct species, principally on the basis of the bilobed gibbosity at the connate base of the lateral sepals, separating it from *I. utricularioides*, in which the gibbosity is usually simple. All other characters are so similar that it does not seem that the structure of the gibbosity (which, in the somewhat variable *Ionopsis utricularioides*, is not constantly simple) alone suffices for maintainance of *I. pal-*

lidiflora as distinct. It is, consequently, here reduced to synonymy.

Kegeliella *Mansfeld*

Kegeliella Houtteana (*Reichb.f.*) *L.O.Williams* in Ann. Mo. Bot. Gard. 29 (1942) 347.

Kegelia Houtteana Reichenbach fil. in Bot. Zeit. 10 (1852) 670.

A rather rare species, *Kegeliella Houtteana* occurs in Panama, Dutch Guiana, Jamaica and Trinidad. Both collections from Trinidad are recent, and, consequently, the genus was not reported from the Colony by Cogniaux.

Trinidad: Heights of Guanapo, August 24, 1930, *Skinner & Robinson s.n.* (Herb. Ames 36524); Morne Bleu, January 10, 1931, *Williams s.n.* (Herb. Trin. 12455).

Macradenia *R. Brown*

Macradenia lutescens *R. Brown* in Bot. Reg. (1822) t. 612.

A specimen was cited from Trinidad in the original description of *Macradenia lutescens*, but it was from cultivated material. There was, therefore, some doubt that this species, known from Florida, Cuba and Colombia, represented a native element of the Trinidad flora. Broadway's collection, reported as growing in "forests," albeit with no definite locality, establishes the fact that *Macradenia lutescens* is native on the island.

Trinidad: February 7, 1931, *Broadway s.n.* (Herb. Ames 67862).

Maxillaria *Ruíz & Pavón*

Maxillaria albiflora *Ames & Schweinfurth* Sched. Orch. 8 (1925) 56.

This represents the second and a topotypical collection of *Maxillaria albiflora*. The leaves and flowers are slightly smaller than in the material of the type (*Freeman & Wil-*

liams s.n.), but all the essential characters show no deviation.

TRINIDAD: Mount Tucuche, alt. 1500 ft., February 28, 1954, *Baker s.n.* (Herb. Trin. 15113).

Maxillaria Broadwayi (*Cogn.*) *R. E. Schultes comb. nov.*

Ornithidium Broadwayi Cogniaux in Urban Symb. Antill. 6 (1910) 612.

Material of this endemic of Tobago has not been available to me for study, but Cogniaux's very ample description of it enumerates so many differentiating characters that there can be no doubt as to its validity as a species. It seems that the transfer from *Ornithidium* to *Maxillaria* has not hitherto been made for this specific concept.

TOBAGO: Between Adelphi and Belmont, *Broadway 2474* (cited by Cogniaux).

Maxillaria trinitatis *Ames* Sched. Orch. 2 (1923) 34.

Maxillaria trinitensis [Ames apud] Broadway in Orch. Rev. 34 (1926) 202, *sphalm.*

Hitherto known only from the type collection, *Maxillaria trinitatis* is now recorded from several additional localities in Trinidad.

The type collection was cited by Ames as *Broadway 9890*. This, however, is the number of the specimen, a duplicate type, in the Trinidad Herbarium. Inasmuch as the type is deposited in the Ames Herbarium, some confusion might result from the transfer of this number to the collector. Mr. Broadway seldom used collection numbers; the numbers which have been used as though they were Broadway's invariably refer to the accession number of the specimen in the Trinidad Herbarium.

TRINIDAD: Las Cuevas Heights, January 4, 1861 (Herb. Trin. 1832); Heights of Aripo, January 10–26, 1922, *Broadway s.n.* (Herb. Ames 22672, TYPE; Herb. Ames 67049; Herb. Trin. 9800); Tucuche, Jan-

uary 10, 1922, *Freeman & Williams s.n.* (Herb. Trin. 10085); Trail to El Tucuche, January 2, 1948, *Simmonds 240* (Herb. Trin. 14070); El Tucuche, March 27, 1955, *Downs & Aitken 39* (Herb. Ames 67842).

Maxillaria variabilis *Bateman ex Lindley* Bot. Reg. 23 (1837) sub t. 1986.

Common throughout Middle America and known also from British Guiana, *Maxillaria variabilis* has apparently never been reported for the flora of Trinidad, notwithstanding the fact that the only two specimens of it which we have from the island were collected almost a century ago.

TRINIDAD: January 9, 1864 (Herb. Trin. 1821); Cedros, July 4, 1866, *Ristoe s.n.* (Herb. Trin. 2895); Tabaquite, January 13, 1955, *Downs & Aitken 50* (Herb. Ames 67798).

NOTYLIA *Lindley*

The first dichotomy in Cogniaux's key to the six species of *Notylia* which he recognized for Trinidad and Tobago is based on the presence and absence of a callus at the base of the lip. He separated *Notylia punctata* from the other five species because it alone had a callus. An examination of all material available from Trinidad indicates that a callus is present in every one of the species-concepts. According to Mr. Charles Schweinfurth, this character is very misleading and does not hold. Another character which Cogniaux has employed is the condition of the tips of the sepals: whether straight or revolute. This character is highly untrustworthy, for both straight and revolute sepal-tips can be found on flowers taken from a single inflorescence. Likewise, the length of inflorescence and the degree of union of the sepals seem to be extremely variable and unreliable characters. The same variability has been found in the muticous and apiculate condition of the sepals.

The following treatment of *Notylia* is proposed, inasmuch as *N. angustifolia* and *N. nana* do not appear to present any really stable and fundamental differences

which could be considered as specific; and since the concepts described by Cogniaux as *N. apiculata* and *N. Broadwayi* differ so slightly from *N. punctata* that one would hardly be justified in calling them varieties. *Notylia incurva* remains somewhat of a mystery. There is in the Trinidad Herbarium (*2092*) an inflorescence, the flowers of which differ from those of all other local material, which I am tentatively calling *Notylia incurva*. Lindley's description of the concept is so vague that it would be difficult to assign this name with certainty to any specimen. The specimen *2092* was determined, presumably at Kew by Rolfe, as representing this concept, and all of the characters of the flower would seem to agree with those specified by Lindley for *Notylia incurva*. Even though the name *Notylia incurva* is apparently rather ambiguous, I believe that the best course at present is to refer our specimen to it. The only certainty is that this specimen differs markedly, especially in shape of the lip, from all other Trinidad material. The lip is very broadly hastate instead of being very narrowly trulliform.

It would seem, then, that three species of *Notylia* are known from Trinidad and Tobago. These can be distinguished according to the following key.

1. Leaves narrowly linear. *N. angustifolia*

1A. Leaves broadly oblong or elliptic.

2. Lip narrowly trulliform, apically acute or subobtuse. *N. punctata*

2A. Lip broadly hastate, subtrilobulate, apically rounded. *N. incurva*

A summary of specimens referred to these concepts and a synonymy are herewith given.

Notylia angustifolia *Cogniaux* in Urban Symb. Antill. 6 (1910) 618.

Notylia nana Cogniaux loc. cit. 619.

Trinidad: Caparo, March 27, 1908, *Broadway 2348* (Herb. Ames 10655a, 11684); Oropouche via Valencia, March 5, 1931, *Broadway 7454* (Herb. Ames 10655); *Broadway 2431* (cited by Cogniaux: Type of *Notylia nana; Hart s.n.* (cited by Cogniaux: Type of *Notylia angustifolia*).

Notylia incurva *Lindley* in Bot. Reg. 24 (1838) Misc. No. 167.

Trinidad: Botanic Gardens, *Hart s.n.* (Herb. Trin. 2092); *Hort. Loddiges* (cited by Cogniaux).

Notylia punctata (*Ker*) *Lindley* in Bot. Reg. 11 (1825) sub. t. 930.

Pleurothallis punctata Ker in Bot. Reg. 9 (1823) t. 759.

Gomeza tenuiflora Loddiges Bot. Cab. 9 (1824) t. 806.

Notylia apiculata Cogniaux in Urban Symb. Antill. 6 (1910) 617.

Notylia Broadwayi Cogniaux loc. cit. 618.

Trinidad: Botanic Gardens, *Hart s.n.* (Herb. Trin. 5665); Agua Santa, near Arima, 1908, *Broadway s.n.* (Herb. Ames 11692); Agua Santa, Arima, July 26, 1908, *Broadway s.n.* Herb. Ames 10671, 10672); North Trace via Princes Town, August 19, 1918, *Broadway s.n.* (Herb. Trin. 8835); Siparia, April 4, 1918, *Rogers s.n.* (Herb. Trin. 8768); Quare River, July 12, 1925, *Williams & Freeman s.n.* (Herb. Trin. 11264); Jackson Trace via Cap de Ville, April 1, 1931, *Broadway 7503* (Herb. Ames 37541); Tamana, May 17, 1934, *Bruins-Lich. s.n.* (Herb. Trin. 13020); *Woodford ex Loddiges* (cited by Cogniaux); *Broadway A, B, C, D* (cited by Cogniaux).

Octomeria *R. Brown*

Octomeria grandiflora *Lindley* in Bot. Reg. 28 (1842) Misc. 64.

Cogniaux did not report this species from Trinidad. It is known from Brazil and Bolivia. The *Broadway* specimens are smaller in all parts than typical *Octomeria grandiflora*, but they are morphologically indistinguishable from this variable concept. The only other species of this genus on Trinidad appears to be *Octomeria graminifolia* (L.) R. Br.

Trinidad: January 6, 1927, *Broadway 6515* (Herb. Ames 66920).

Peristeria *Hooker*

Peristeria cerina *Lindley* in Bot. Reg. 23 (1837) t. 1953.

Cogniaux did not report this rare orchid from Trinidad. It was apparently first collected in 1930 by Broadway who reported it the following year (in Orch. Rev. 39 (1931) 35), stating that "this *Peristeria* seems to be only known from the Siparia districts of the Colony, where it has been met attached to trees, but is a scarce Trinidad plant."

Trinidad: Siparia, April 11, 1930, *Broadway 7429* (Herb. Ames 36523).

Peristeria pendula *Hooker* in Bot. Mag. 63 (1836) t. 3479.

This species appears hitherto not to have been reported from Trinidad with specimen citation.

Trinidad: Siparia, April 14, 1916, *Broadway s.n.* (Herb. Trin. 7656).

Pleurothallis *R. Brown*

Pleurothallis acutissima *Lindley* Fol. Orch. (1859) Pleurothallis No. 277, 43.

Pleurothallis sertularioides (Sw.) Sprengel var. *trinitensis* Grisebach Fl. Brit. W. Ind. Isl. (1864) 609.

There seems to be no doubt that *Pleurothallis sertularioides* var. *trinitensis* can be referred to *P. acutissima.*

Trinidad: Aripo, April 16, 1908, *Broadway 2333* (Herb. Ames 10663); Aripo Savannah, February 13, 1915, *Freeman s.n.* (Herb. Trin. 8025; Herb. Ames 67922); Matura, September 1, 1925, *Williams, Freeman & Cheesman s.n.* (Herb. N. Y. Bot. Gard.; Herb. Trin. 11326).

Pleurothallis archidiaconi *Ames* Sched. Orch. 9 (1925) 29.

The *Downs & Aitken* material represents the second collection of this Trinidad endemic.

Trinidad: Cumaca, December 1954 [flowering February 6, 1955], *Downs & Aitken 11* (Herb. Ames 67846).

Pleurothallis ciliata *Knowles & Westcott* Flor. Cab. 1 (1837) 39, t. 19.

Cogniaux did not cite this species as native to Trinidad. It is known from Colombia, Peru, British Guiana and Trinidad.

Trinidad: Agua Santa, Arima, April 16, 1908, *Broadway 2341* (Herb. Ames 10643); Caparo, January 1, 1915, *Broadway s.n.* (Herb. Trin. 7840); Cedros, April 5, 1918, *Sankeralli s.n.* (Herb. Trin. 8791); Quare River, January 25, 1930, *Broadway 7449* (Herb. Ames 37545, 66919).

Pleurothallis diffusa *Poeppig & Endlicher* Nov. Gen. ac Sp. 1 (1835) 49, t. 86.

Known in the Andean regions from Bolivia and Peru north to Colombia, *Pleurothallis diffusa* is not enumerated in Cogniaux's orchid list of Trinidad.

Trinidad: (Herb. Trin. 6432); Aripo, November 11, 1863 (Herb. Trin. 1818); Heights of Aripo, April 11, 1922, *Broadway s.n.* (Herb. Trin. 10567); *Downs & Aitken 33* (Herb. Ames 678451).

Pleurothallis discoidea *Lindley* in Bot. Reg. 31 (1835) sub t. 1797.

Pleurothallis leptopetala Cogniaux ex Urban Symb. Antill. 6 (1910) 693.

It seems that Cogniaux's *Pleurothallis leptopetala* represents the same species concept as Lindley's *P. discoidea* and must, consequently, be reduced to synonymy.

Pleurothallis discoidea was described on the basis of a specimen from Trinidad, but the original and subsequent descriptions (Lindley in Fol. Orch. (1859) Pleurothallis 19; Grisebach, Fl. Brit. W. Ind. Isl. (1864) 608; Cogniaux, loc. cit. 406) are short and lack detail. With the original description, Lindley refers to a drawing in the Hooker Herbarium ("v. ic. pict. in hb. Hooker"), but this illustration appears to have been lost. Mr. Victor A. Summerhayes has sent from the Lindley Herbarium a tracing of the rough ink copy of the original drawing.

A comparison of the characters which Cogniaux so carefully set forth in his description of *Pleurothallis leptopetala* with this drawing and with the original description of *P. discoidea* indicates that, in all essential characters, the two concepts are identical. A study of the ample Trinidadian material hitherto determined as *Pleurothallis leptopetala* reveals that the lip may vary from cordate-ovate to triangular-ovate and from apically subacute to rather obtuse; the margins may be lightly sinuate or entire. The material examined shows little variation in relative sizes of floral parts.

Cogniaux, in his description of *Pleurothallis discoidea*, characterized the dorsal sepal as twice as long as the lateral sepals. This unusual characteristic is not mentioned in Lindley's original description. It is not indicated by the drawing of the type nor by any of the specimens from Trinidad which I am referring to *Pleurothallis discoidea*.

TRINIDAD: Cunupia, March 23, 1892, *Alexander s.n.* (Herb. Ames 7455); Arima, July 1, 1908, *Broadway s.n.* (Herb. Ames 12722, DUPLICATE TYPE); Base of Mt. Tamana, April 18, 1920, *Britton, Britton & Hazen, 1965* (Herb. Gray 2673); Heights of Aripo, January 10–26, 1922, *Broadway 9882* (Herb. Ames 22679); Heights of Aripo, April 11, 1922, *Broadway s.n.* (Herb. Trin. 10564); Saut d'Eau, December 14, 1930, *Broadway 7439* (Herb. Ames 37343); Caparo, *Broadway 2338* (Herb. Ames 10734).

The following sterile collections are possibly referable to *Pleurothallis discoidea*.

Arima, February 1846 (Herb. Trin. 1623); Arima woods, October 26, 1865 (Herb. Trin. 1963); Tucuche, January 29, 1893, *Hart s.n.* (Herb. Trin. 5206); Tucure River District, June 16, 1917, *Williams s.n.* (Herb. Trin. 8780); Mt. Tamana, April 18, 1920, *Freeman s.n.* (Herb. Trin. 9031); Morne Bleu, February 7, 1922, *Broadway s.n.* (Herb. Trin. 10689); Aripo, September 25, 1924, *Freeman s.n.* (Herb. Trin. 10796); Cumaca Road, 3rd mile, December 27, 1948, *Simmonds 316* (Herb. Trin. 14239).

Pleurothallis ovalifolia (*Focke*) *Reichenbach fil.* in Walpers Ann. Bot. 6 (1861) 188.

Stelis ovalifolia Focke in Tijdschr. Natuur. Wetensch. 2 (1849) 202.

Pleurothallis rhomboglossa Reichenbach fil. in Flora (1865) 276.

This concept has been reported from Trinidad by Cogniaux and by Broadway as *Pleurothallis rhomboglossa*. Mr. Leslie A. Garay, Mr. Charles Schweinfurth and I are in agreement that *Pleurothallis rhomboglossa* should be treated as a synonym of *P. ovalifolia*.

Tobago: Great Dog River Valley, October 12, 1937, *Sandwith 1750* (Herb. Ames 64122).

Trinidad: January 13, 1846 (Herb. Trin. 412); Valencia, April 1920, *Britton s.n.* (Herb. Trin. 9245); Base of Mount Tamana, April 18, 1920, *Britton, Britton & Hazen 1969* (Herb. Ames 20356); Matchepoorie, March 11, 1921, *Britton & Britton 2221* (Herb. Ames 21172); Arena Forests, near Cumuto, December 3, 1926, *Broadway 6433* (Herb. Ames 38347); Cumuto-Tumpuna Road, October 1, 1953, *Ayliffe 145* (Herb. Ames 67011); Diego Martin, May 1956, *Downs & Aitken 94* (Herb. Ames 67011A).

Pleurothallis plumosa *Lindley* in Bot. Reg. 28 (1842) Misc. 72.

Pleurothallis plumosa was described from material (*Loddiges 13*) said to have come from Trinidad. I have seen no collections referable to this species, however, with the single exception of the *Downs & Aitken* specimen cited below, which represents a slightly atypical and rather cleistogamous individual. The species is known from Costa Rica, Venezuela and Trinidad.

Trinidad: Morne Poin, alt. 1200 feet, June 9, 1955, *Downs & Aitken 53* (Herb. Ames 67800).

Pleurothallis velaticaulis *Reichenbach fil.* in Linnaea 22 (1849) 824.

Pleurothallis velaticaulis, known from Cuba, Venezuela, Peru and Middle America, has apparently hitherto not been cited from Trindad.

Trinidad: August 28, 1892, *Hart s.n.* (Herb. Trin. 4782; Herb. Ames 67818); Morne Bleu, February 7, 1922, *Freeman s.n.* (Herb. Trin. 10688); Between El Tucuche and Naranjo, January 2, 1948, *Simmonds 235* (Herb. Trin. 14072; Herb. Ames 68182).

Psilochilus *Barbosa-Rodrígues*

Psilochilus macrophyllus (*Lindl.*) *Ames* Orch. 7 (1922) 45.

Pogonia macrophylla Lindley in Ann. & Mag. Nat. Hist., ser. 3, 1 (1858) 335.

Psilochilus macrophyllus was cited from Trinidad by Cogniaux as *Pogonia macrophylla*. Known from Guatemala, northern South America and several of the islands in the West Indies, it is obviously a rather rare species in Trinidad where it is represented only through one collection: *Sieber 381*.

Scaphyglottis *Poeppig & Endlicher*

Scaphyglottis fusiformis (*Griseb.*) *R. E. Schultes comb. nov.*

Hexadesmia fusiformis Grisebach Fl. Br. W. Ind. Isl. (1864) 623.

Scaphyglottis fusiformis is apparently endemic to the island of Trinidad, where it is not an uncommon element of the flora.

Trinidad: (Herb. Trin. 890); Maracas, March 26, 1861 (Herb. Trin. 1838); Oropouche, April 1896, *Alexander s.n.* (Herb. Trin. 6076; Herb. Ames 66993A); Botanic Gardens, April 1890, *Broadway s.n.* (Herb. Trin. 4031; Herb. Ames 66993); Agua Santa Estate, Arima, April 14, 1908, *Broadway s.n.* (Herb. Ames 10708); Caparo, April 28, 1908, *Broadway 2317* (Herb. Ames 10677, 10678); *Downs & Aitken 31* (Herb. Ames 67313).

Scaphyglottis modesta (*Reichb.f.*) *Schlechter* in Fedde Repert. 23 (1926) 46.

Tetragamestus modestus Reichenbach fil. in Bonplandia 2 (1854) 21.

Scaphyglottis modesta is known from the West Indies and the northern half of South America. It was not included by Cogniaux in his enumeration of Trinidad species. According to Broadway (in Orch. Rev. 35 (1927) 20) "a full-sized plant hangs down with leaf-stems two or more feet in length."

TRINIDAD: Botanic Gardens, March 5, 1918, *Broadway s.n.* (Herb. Trin. 8774); May 26, 1925, *Hombersley s.n.* (Herb. Trin. s.n.); January 11, 1926, *Williams s.n.* (Herb. Trin. 11498); Cumaca Road, 3rd mile, December 27, 1948, *Simmonds 318* (Herb. Trin. 14240).

SPIRANTHES *L. C. Richard*

Spiranthes costaricensis *Reichenbach fil.* in Bonplandia 3 (1855) 214.

Gyrostachys costaricensis (Reichb.f.) O. Kuntze Rev. Gen. Pl. 2 (1891) 664.

Spiranthes costaricensis has apparently never been reported from Trinidad, It has probably been confused with *Spiranthes clata.* Vegetatively, these two species are similar, even though *Spiranthes costaricensis* usually is somewhat smaller than *S. clata.* The differences in flower, however, are such that it should be possible to distinguish the two easily. The apical part of the lip is transverse and broader than long in *Spiranthes clata,* whereas it is oblong-ovate to suborbicular in *S. costaricensis.* I have seen no Trinidad material which could be referred to *Spiranthes clata,* but Cogniaux cites a *Purdie* and a *Crueger* collection as representing this species.

TRINIDAD: February 16, 1849 (Herb. Trin. 1513); Tucuche, January 10, 1922, *Freeman & Williams s.n.* (Herb. Trin. 10084); Aripo Flats, March 25, 1934, *Bruins-Lich s.n.* (Herb. Trin. 12990); Tucuche, January 25, 1953, *Baker s.n.* (Herb. Trin. 14814); Between Brasso Seco and Madamus, January 9, 1955, *Herklots s.n.* (Herb. Trin. 15357; Herb. Ames 67051).

Spiranthes guayanensis (*Lindl.*) *Cogniaux* in Martius Fl. Bras. 3, pt. 4 (1895) 209, t. 47, fig. 2 (as *guyanensis*).

Goodyera guayanensis Lindley Gen. & Sp. Orch. Pl. (1840) 494.

Brachystele guyanensis (Lindl.) Schlechter in Beih. Bot. Centralbl. 37, Abt. 2 (1920) 373.

The spelling of the specific epithet of this concept

should be *guayanensis*, in conformity with the original orthography followed by Lindley. The change (probably in error) instituted by Schlechter has become the most widely used and generally accepted form.

TRINIDAD: Queen's Park, June 2, 1850 (Herb. Trin. 870); Queen's Park, May 1889, *Broadway s.n.* (Herb. Trin. 3792); Botanic Gardens, June 5, 1889, *Broadway s.n.* (Herb. Trin. 3806); Government House Grounds, June 4, 1907, *Broadway s.n.* (Herb. Ames 10171, 10172, 10173, 10174); St. Ann's, June 13, 1922, *Broadway s.n.* (Herb. Ames 39727); *Broadway s.n.* (Herb. Trin. 3913).

STELIS *Swartz*

Stelis trinitatis *Ames* Sched. Orch. 2 (1923) 15.
Stelis trinitensis [Ames apud] Broadway in Orch. Rev. 34 (1926) 134, *sphalm.*

Stelis trinitatis appears to be a very strict endemic at Aripo. The type was collected at the "Heights of Aripo" by Broadway. *Simmonds 230* was found at an altitude of 2000 feet, "by the Caves Trail," and *Simmonds 410* grew at 1200 feet. The *Downs & Aitken* collection was made in the "Cave Region."

The only other species of *Stelis* known from Trinidad and Tobago is the widespread *S. ophioglossoides* (Jacq.) Sw.

TRINIDAD: Mount Aripo, December 24, 1947, *Simmonds 230* (Herb, Trin. 14023); Mount Aripo, October 22, 1949, *Simmonds 410* (Herb. Trin. 14444; Herb. Ames 67804); Aripo, March 20, 1955, *Downs & Aitken 34* (Herb. Ames 67843).

STENIA *Lindley*

Stenia pallida *Lindley* in Bot. Reg. 23 (1837) sub t. 1997; 24 (1838) t. 20.

Stenia pallida is known from Venezuela, British Guiana and Trinidad. The accompanying plate, drawn from the herbarium specimens and alcohol material sent in by Dr. Downs and Dr. Aitken, and from their excellent photographs of the living plant, is published particularly to

point out a character which has not hitherto been described or figured: the lip is inverted and uppermost.

TRINIDAD: Botanic Gardens, 1894, *Hart s.n.* (Herb. Trin. 5591); Heights of Aripo, January 10–26, 1922, *Broadway s.n.* (Herb. Trin. 9898); El Tucuche, alt. about 2000 feet, March 20, 1955 [flowered May 19, 1955], *Downs & Aitken 38* (Herb. Ames 77844, 67863); *Bradford s.n.* (cited by Cogniaux).

TRIPHORA *Nuttall*

Triphora surinamensis (*Lindl.*) *Britton* in Britton & Wilson Sci. Surv. Porto-Rico and Virgin Islands 5 (1924) 184.

Pogonia surinamensis Lindley in Hooker London Journ. Bot. 2 (1843) 674.

This species was reported from Trinidad as *Pogonia surinamensis*. The several recently-made collections indicate that this rather widely distributed species is not uncommon in Trinidad.

TRINIDAD: Maraval, July 4, 1847, *Crueger s.n.* (Herb. Trin. 414); O'Meara Savannah, July 7, 1848, *Purdie* (?) *s.n.* (Herb. Trin. 1625); Mora Forest, June 26, 1925, *Broadway s.n.* (Herb. Ames 30415); Bamboo Plantation, St. Joseph, October 1949, *Baker s.n.* (Herb. Trin. 14437; Herb. Ames 67927).

VANILLA *Swartz*

Vanilla Hartii *Rolfe* in Kew Bull. 1899 (1899) 133.

Cogniaux listed *Vanilla Hartii*, citing the type (*Hart 6355*), but indicating that he had not seen it. The numerous collections made since 1898 show that *Vanilla Hartii* is a very distinct species. It is endemic to Trinidad and Tobago.

TOBAGO: Widow Woods, March 6, 1911, *Broadway s.n.* (Herb. Gray 1419.

TRINIDAD: Cabasterre, Arima, April 1898, *Hart 6355* (Herb. Trin. s.n.; Herb. Ames 67784); Agua Santa, Arima, May 4, 1915, *Broadway s.n.* (Herb. Trin. 8762); Mora Forest, east of Sangre Grande, April 10, 1921, *Britton 2841* (Herb. Gray 1420); Cunupia, *Hart s.n.* (Herb. Trin. 6356; Herb. Trin. s.n.).

Vanilla Wrightii *Reichenbach fil.* in Flora 48 (1865) 273.

Vanilla Wrightii must be rather rare in Trinidad. It is known only from these two collections.

TRINIDAD: Melajo Forest, May 1955, *Downs & Aitken 56* (Herb. Ames 67793); *Fendler 1007* (cited by Cogniaux).

WARCZEWICZELIA *Reichenbach fil.*

Warczewiczella flabelliformis (*Sw.*) *Cogniaux* in Urban Symb. Antill. 4 (1903) 182.

Epidendrum flabelliforme Swartz Prodr. (1788) 123.

Cogniaux cited for Trinidad only a *Bradford* collection for *Warczewiczella flabelliformis.* The recent collections indicate that it is a rather widely occurring orchid on the island.

TRINIDAD: March 1890, *Broadway s.n.* (Herb. Ames 7598); Tabaquite, November 25, 1924, *Farfan s.n.* (Herb. Trin. 11198), August 26, 1927 (Herb. Trin. 11778); Morne Bleu, March 23, 1928, *Hombersley, Freeman & Williams s.n.* (Herb. Trin. 11959).

EXPLANATION OF THE ILLUSTRATION

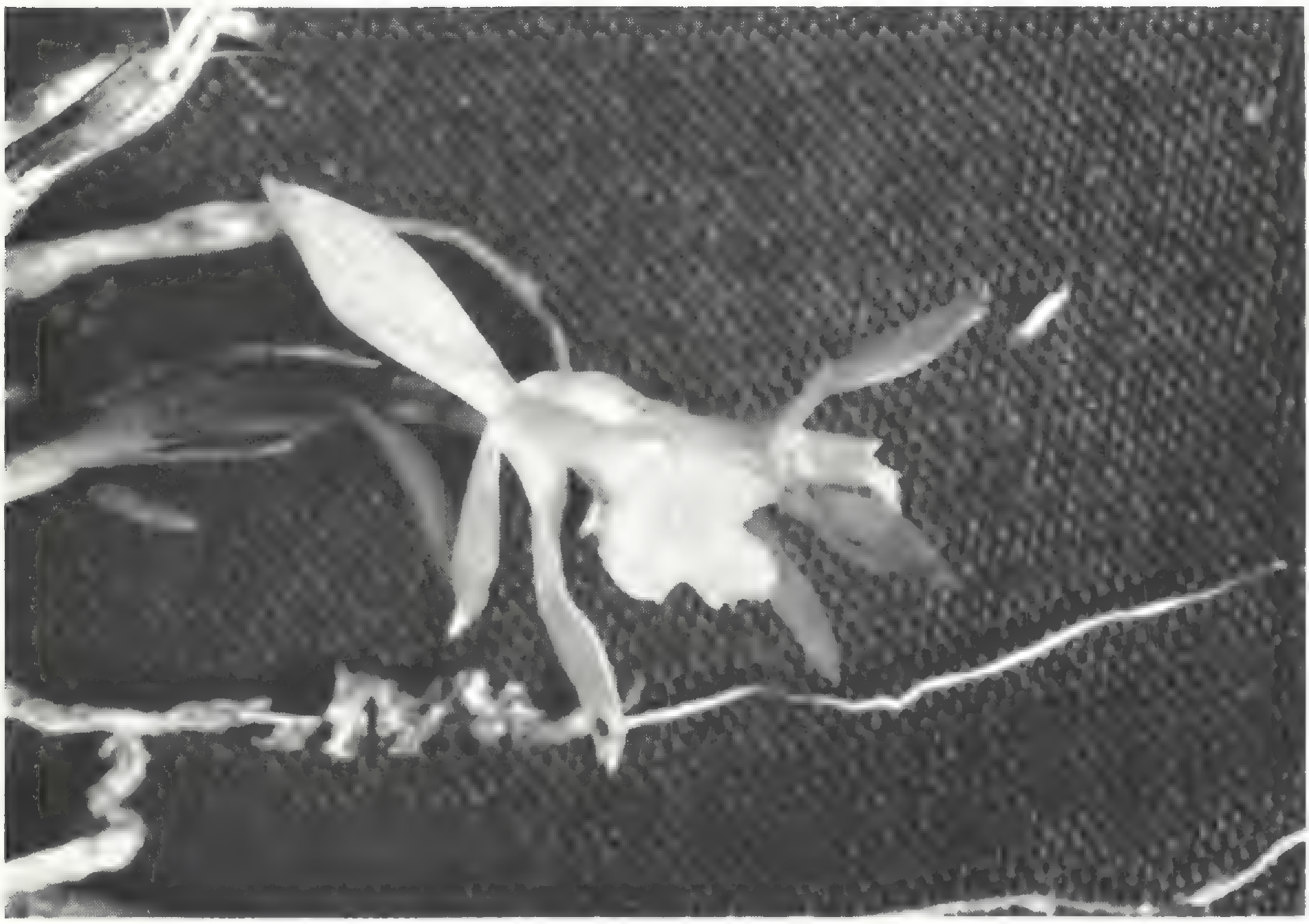
PLATE XLVIII. (*Upper*) DICHAEA MURICATA (*Sw.*) *Lindl.* Flowering tip of *Downs & Aitken 22.* (*Lower*) EPIDENDRUM HARTII *Rolfe.* Flowers of *Downs & Aitken 30.*

Plate XLVIII

EXPLANATION OF THE ILLUSTRATION

PLATE XLIX. (*Upper*) EPIDENDRUM ROUSSEAUEAE *Schltr.* Flowers of *Downs & Aitken 46*. (*Lower*) Habit of *Downs & Aitken 46*.

Plate XLIX

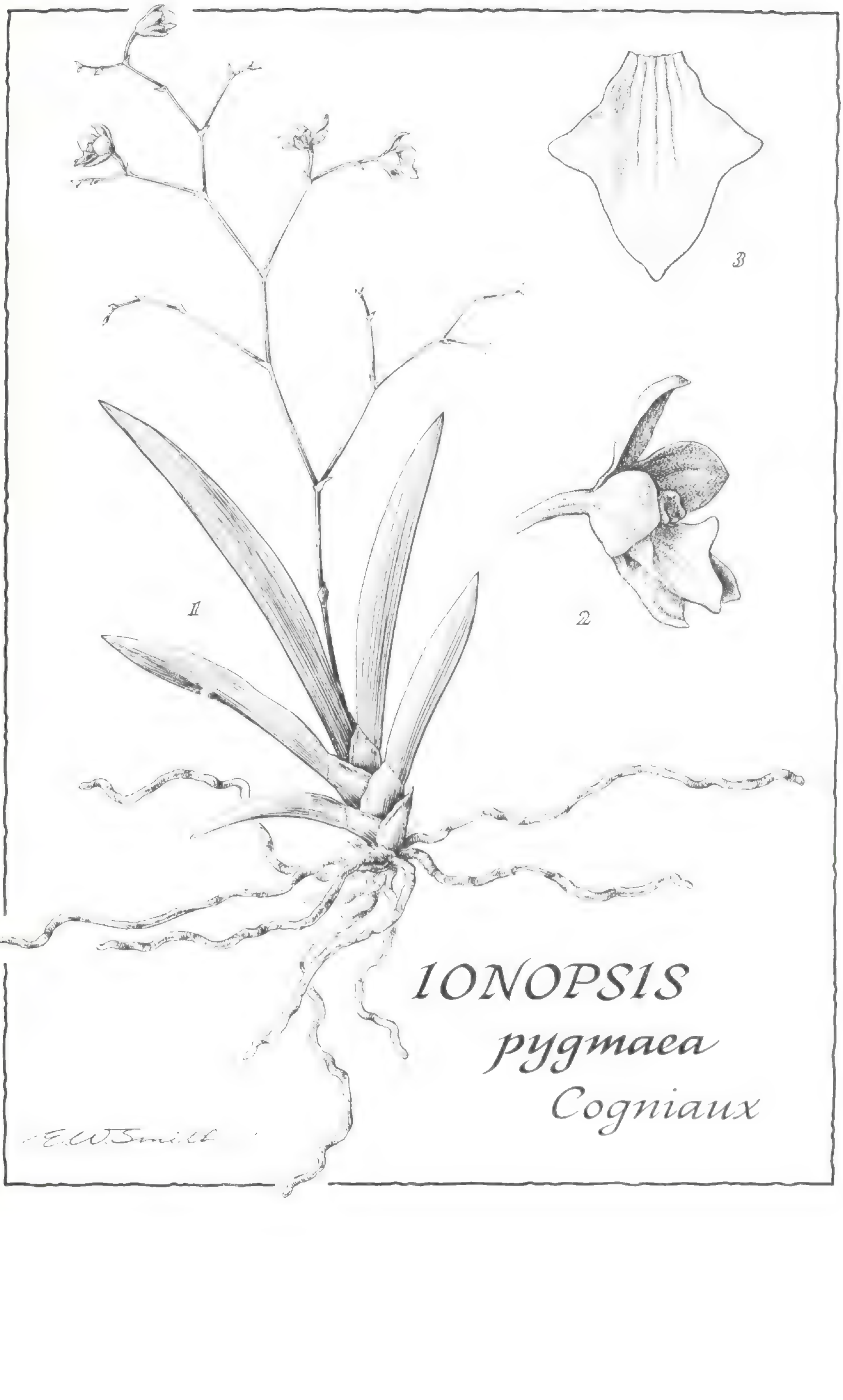


EXPLANATION OF THE ILLUSTRATION

PLATE L. IONOPSIS PYGMAEA *Cogniaux*. 1, habit, two and one half times natural size. 2, flower, three-quarter view, about eleven times natural size. 3, lip, expanded, eighteen times natural size.

Drawn by ELMER W. SMITH

PLATE L



IONOPSIS

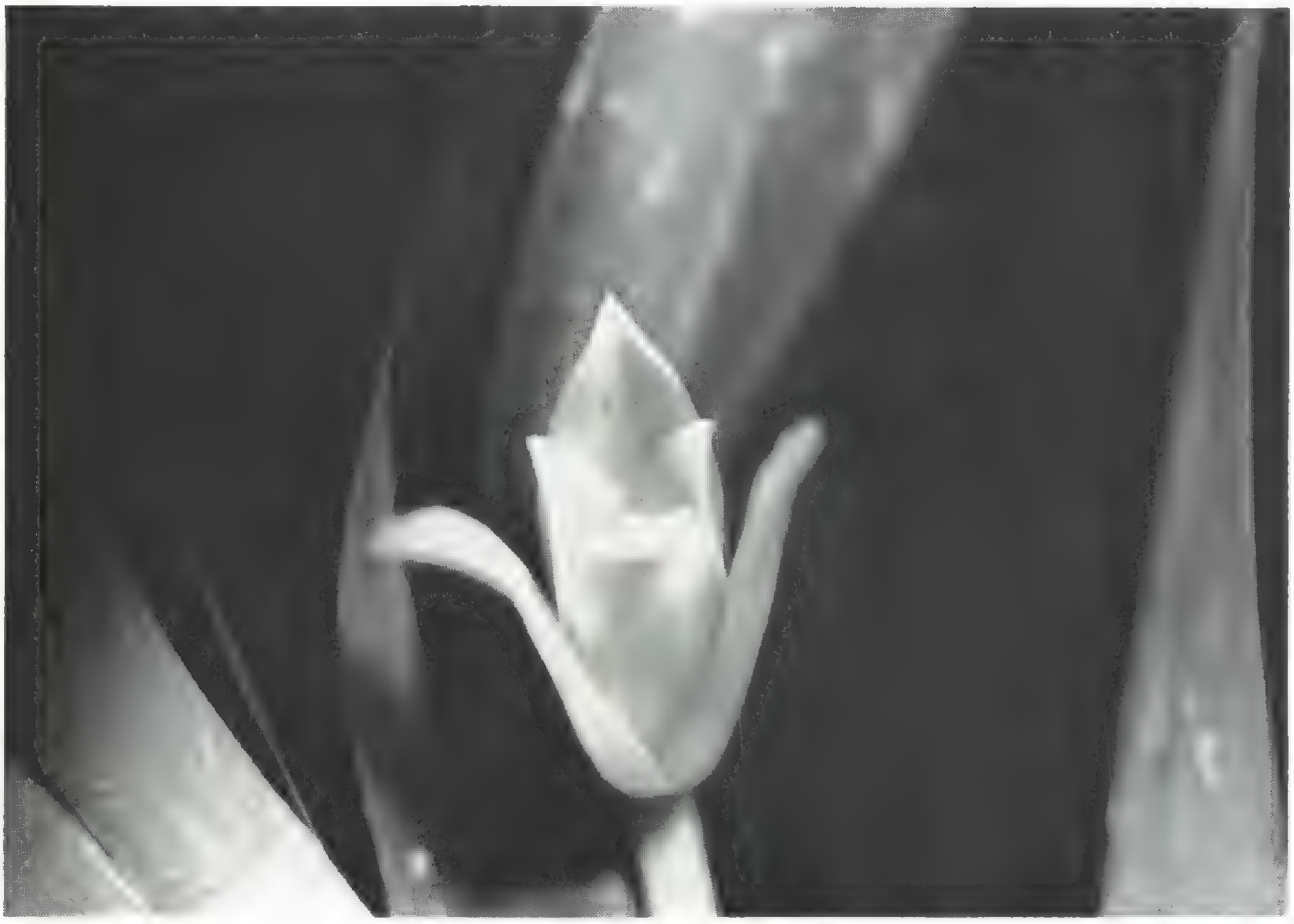
pygmaea

Cogniaux

EXPLANATION OF THE ILLUSTRATION

PLATE LI. (*Upper*) MAXILLARIA TRINITATIS *Ames*. Habit and flower of *Downs & Aitken 39*. (*Lower*) MAXILLARIA VARIABILIS *Batem. ex Lindl.* Flower of *Downs & Aitken 50*.

Plate LI



EXPLANATION OF THE ILLUSTRATION

PLATE LII. (*Upper*) SCAPHYGLOTTIS FUSIFORMIS (*Griseb.*) *R. E. Schultes.* Habit of *Downs & Aitken 31.* (*Lower*) Flower of *Downs & Aitken 31.*

Plate LII

EXPLANATION OF THE ILLUSTRATION

PLATE LIII. (*Upper*) PLEUROTHALLIS DIFFUSA *Poepp. & Endl.* Part of the inflorescence of *Downs & Aitken 33*. (*Lower*) STELIS PALLIDA *Lindl.* Habit and flower of *Downs & Aitken 38*.

Plate LIII

EXPLANATION OF THE ILLUSTRATION

PLATE LIV. STENIA PALLIDA *Lindl.* 1, plant with flower. 2, lip and column, lateral view. 3, lip from above (i.e., from the side facing the column). 4, lateral sepal. 5, petal. 6, dorsal sepal. All natural size.

Drawn by ELMER W. SMITH

STENIA
pallida
Lindley
1
2
3
4
5
6
F.W. Smith

NOTES ON PERUVIAN ORCHIDS

BY
CHARLES SCHWEINFURTH

THE examination of loans obtained chiefly from the Presl Herbarium at Prague by Mr. Leslie A. Garay of the University of Toronto has revealed the necessity of making several changes in nomenclature.

HABENARIA LINIFOLIA *Presl* Reliquiae Haenkeanae 1 (1827) 91.

The type collection of *Habenaria linifolia*, borrowed from Prague, is incomplete, showing only the upper portion of the plant including two leaves and a loosely flowered spike, but it definitely agrees with the description. The plant, however, resembles certain forms of *Habenaria dilatata* (Pursh) Hooker. On examining a flower, moreover, which likewise matches the description, it was found that the lip exactly coincides with that of some forms of the latter species.

Since *Habenaria dilatata* is a boreal species extending only as far south as New Mexico and California and has never been recorded from Central or South America, its occurrence in Peru seems well nigh incredible. Moreover, it is a known fact that some of the species described by Presl in the above work have been confused owing to mixed labels. It seems desirable, therefore, that *Habenaria linifolia* be reduced to synonymy and omitted from the list of Peruvian species.

Pleurothallis diffusa *Poepp. & Endl.* var. **grandiflora** (*C. Schweinf.*) *C. Schweinfurth comb. nov.*

Pleurothallis semipellucida Reichb.f. var. *grandiflora* C. Schweinf. in Bot. Mus. Leafl. Harvard Univ. 15 (1951) 102.

Mr. Garay has pointed out that the concept *Pleurothallis semipellucida* is synonymous with the earlier *P. diffusa.* Consequently, the above transfer becomes necessary.

Pleurothallis secunda *Poepp. & Endl.* var. **longiracema** (*C. Schweinf.*) *C. Schweinfurth comb. nov.*

Pleurothallis Lindenii Lindl. var. *longiracema* C. Schweinf. in Bot. Mus. Leafl. Harvard Univ. 16 (1953) 53.

Since Mr. Garay has likewise indicated that the species described as *Pleurothallis Lindenii* is referable to the earlier *P. secunda*, it is necessary to publish the above change.

Epidendrum dichotomum *Presl* Reliquiae Haenkeanae 1 (1827) 101, non Lindl. Fol. Orch. Epidendrum (1853) 71, no. 223.

Epidendrum brachyphyllum Lindl. Fol. Orch. Epidendrum (1853) 72, no. 225.

Epidendrum Lindenii Lindl. Bot. Reg. 31 (1845) Misc. 48, no. 59; Fol. Orch. Epidendrum (1853) 72, no. 227, non *Epidendrum Lindenii* Lindl. in Ann. & Mag. Nat. Hist. 12 (1843) 397.

Epidendrum euxoense Schltr. in Fedde Repert. Beih. 9 (1921) 82; Mansf. in Fedde Repert. Beih. 57 (1929) t. 117, nr. 460.

Epidendrum tarmense Schltr. in Fedde Repert. Beih. 9 (1921) 94; Mansf. in Fedde Repert. Beih. 57 (1929) t. 122, nr. 477.

Epidendrum inconstans Ames in Bull. Torr. Bot. Club 58 (1931) 350.

Examination of the type of *Epidendrum dichotomum*, obtained from Prague, shows that it represents the highly variable and widely dispersed species that has been variously designated as *E. brachyphyllum*, *E. Lindenii*, *E. cuzcoense*, *E. tarmense* and *E. inconstans*.

The plants and inflorescences of this collection, while they show considerable variation in size, correspond reasonably well with the description. Moreover, this record was considered by Reichenbach himself as truly to represent the type. The flowers appear to be more or less larger than those described, but they are well within the range of the *E. brachyphyllum* complex. The large, lobed callus on the lamina of the lip appears in this collection to be somewhat farther extended on the disc than usual in *E. brachyphyllum*, yet it is closely similar to that of some forms attributed to that species.

It seems justifiable to consider *E. dichotomum* as the earliest name to represent this polymorphic concept.

Epidendrum Funkii *Reichb.f.* in Linnaea 22 (1849) 839.

Epidendrum brachycladium Lindl. Fol. Orch. Epidendrum (1853) 60, no. 186.

Epidendrum brachycladium (B) *crassipes* Lindl., l.c.

Epidendrum crassipes Kränzl., in Engler Bot. Jahrb. 54, Beibl. 117 (1916) 25.

A study of the type of *Epidendrum Funkii* makes it evident that this species includes the concepts described as *E. brachycladium* and *E. brachycladium* var. *crassipes* (later set apart as *E. crassipes*).

Both vegetatively and florally it is a counterpart of the plant designated as *E. brachycladium* (B) *crassipes*, as shown by a photograph of Lindley's type with floral

analysis, in the Ames Herbarium, having the base of the stem fusiform-thickened and the petals and the lobes of the lip conspicuously denticulate or lacerate-dentate.

The typical form of *E. brachycladium*, described without the base of the stem, was said to have the petals and the lobes of the lip "but little toothed, or even entire."

A wide range of specimens in the Ames Herbarium referable to this polymorphic species shows a marked difference in the degree of bulbous dilation in the basal part of the stem and a great variation in the extent of toothing of the petals and the lobes of the lip. It appears preferable, therefore, to agree with Lindley (l.c.) and regard these plants as inseparable.

It seems worthy of note that a flower from the type of *E. Funkii* shows a petal which is irregularly denticulate (not three-lobed as described) and lateral lobes of the lip which are evenly lacerate-dentate (not retuse as stated).

Epidendrum Haenkeanum *Presl* Reliquiae Haenkeanae 1 (1827) 100; Lindl. Fol. Orch. Epidendrum (1853) 58, no. 179.

Epidendrum juninense Schltr. in Fedde Repert. Beih. 9 (1921) 87; Mansf. in Fedde Repert. Beih. 57 (1929) t. 119, nr. 466.

The type of *E. Haenkeanum*, likewise borrowed from Prague, appears to be inseparable from *E. juninense*. While it consists of a simple stem, the lower portion shows an incipient branch, as is characteristic of the latter species. The general appearance, as well as the leaves, panicle and flowers, are quite indistinguishable from those of *E. juninense*.

Epidendrum laxum *Poeppig & Endlicher* Nov. Gen. ac Sp. 2 (1837 38) 2; Lindl. Fol. Orch. Epidendrum (1853) 57, no. 176.

Epidendrum macrothyrsis Lehm. & Kränzl. in Engler Bot. Jahrb. 26 (1899) 472.

An examination of the type specimens of *Epidendrum laxum*, which were borrowed from Vienna, makes it certain that this species includes *E. macrothyrsis*, as Schlechter claimed (in Fedde Repert. Beih. 27 (1924) 67. It does not appear that the leaves of *E. laxum*, at least in the dried material, are either fleshy or shining, characters formerly used, in part, to separate these concepts.

This species appears to vary considerably as to the size and proportions of the leaves and especially of the floral segments. One collection seems to be particularly aberrant in having small flowers with short lateral lobes of the lip and a relatively large, narrowly triangular midlobe. However, in view of the apparent variability of the species, it seems scarcely worthy of even varietal recognition.

Polystachya foliosa (*Lindl.*) *Reichb.f.* in Walp. Ann. 6 (1863) 640.

Stelis foliosa Lindley in Ann. Nat. Hist. 2 (1839) 330, t. 17.

Polystachya nana (Poepp. & Endl.) Reichb. f. in Walp. Ann. 6 (1863) 638.

The extremely widespread and variable species of Polystachya, which was referred to *P. nana* (Poepp. & Endl.) Reichb.f. (in Bot. Mus. Leafl. Harvard Univ. 17 (1955) 51), should bear the name *P. foliosa* (Lindl.) Reichb.f.

The epithet *nana*, mistakenly regarded by me as a nomen, is untenable, as it was validly used by Klotzsch in 1853 (in Ind. Sem. Hort. Berol. (1853) nr. 5), ten years before Reichenbach employed the name.

Apparently *Stelis foliosa* (1839) is the earliest name-bringing synonym.

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EVOLUTION LEADING TO THE FORMATION OF THE CUPULATE FRUIT CASE IN THE AMERICAN *MAYDEAE*

BY

WALTON C. GALINAT[1]

IN the grasses certain characteristic floral structures remain associated with the caryopses following dispersal and, as a result, provide protection and facilitate dissemination. In a few genera the protective role of the spikelet bracts (glumes, lemmas, and paleas) is supplemented or replaced by other structural devices. For example, there may be an involucre of bristles below a spikelet (*Setaria* and *Pennisetum*); a bur of united bristles about each spikelet (*Cenchrus*); an indurated spathe subtending and enclosing each pistillate spikelet (*Coix*); a rosette of spathes subtending and enclosing the entire pistillate inflorescence or ear (*Zea*); or, as will be discussed here, a cupulate rachis-segment enveloping each pistillate spikelet (*Euchlaena* and *Tripsacum*).

Discussion of the "cupulate fruit case," as well as its relationship to the "cupule" of maize (*Zea Mays*), involves use of a special nomenclature which has been developed in the numerous papers on the American *Maydeae*. Sturtevant (1899, p. 11), who first used the term "cupule," has defined it as a "corneous alveolus of the cob" immediately above the attachment point of each

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pair of pistillate spikelets. The name "fruit case" was apparently first used by Mangelsdorf and Reeves (1939) to designate a structure protecting the caryopsis in the *Maydeae*. Mangelsdorf (1948) states that the fruit case of teosinte (*Euchlaena*) "comprises an indurated glume of restricted proportions plus an indurated rachis-segment [internode] which internally is concave and partly surrounds the caryopsis." Mangelsdorf also uses the term fruit case to refer to the floral bracts alone when the rachis-segment is reduced to a mere appendage, as in tunicate teosinte.

Fruit Cases in the American *Maydeae*

Maize. The floral bracts which usually form the fruit case in other grasses are of such reduced proportions in modern maize that they are completely obscured by the grain on a mature, well-filled ear. In the early stages of development, however, the ovary and even the young caryopsis is usually enclosed by floral bracts; the pistillate spikelets are paired and each pair is associated with a cupule (Plate LV, figs. 1 and 2). This combination of structures is arranged about a ridged rachis in several longitudinal rows in which the cupules for one row of paired spikelets alternate with those of adjoining paired spikelets on either side (Plate LV, fig. 3). The entire polystichous structure which bears hundreds of exposed caryopses is enclosed and protected by numerous large spathes borne below on the shank. Although this protective device in modern maize prevents natural dissemination, it is ideally adapted for harvesting by hand.

Teosinte and Tripsacum. The fruit cases of teosinte and *Tripsacum* are small, highly lignified, box-like structures which occur in two alternating ranks. They are formed largely by what at first appear to be deeply hollowed rachis-segments. The openings of these "hollow

segments" are closed by the outer glumes of the enclosed spikelets. The spikelets, which are sessile and solitary, are oriented in the same plane as that of the rachis and are sunken within the cavity.

The inflorescences of these close relatives of maize have slight differences which will be considered in terms of the hypothesis that teosinte originated from the ancient hybridization of maize and *Tripsacum* (Mangelsdorf and Reeves, 1939). Furthermore, we assume that the maize germplasm in teosinte is now rather similar to that of modern maize, since teosinte is being frequently outcrossed to maize. Extreme compression[1] of the pistillate spike and its shank (a peduncle including an entire branch) is an outstanding feature of domesticated maize (Weatherwax, 1935; Mangelsdorf, 1945). The internodes of the shank are so short that all of the leaf-sheaths (husks) remain in a protective cover upon the mature ear. Increased compression which was derived from modern maize is thought to have produced the fruit case and peduncle of teosinte by modifying the characteristics of *Tripsacum* as follows. Compression of the trapezoidal or almost rectangular form of the rachis-segment of *Tripsacum* has produced the triangular shape characteristic of the rachis-segment in the most maize-like races of teosinte. The elongated peduncle in *Tripsacum* usually holds the mixed inflorescences aloft above all leaves, and continuity of the pistillate region is maintained during maturation by masses of parenchyma which connect adjoining rachis-segments. A slight compression produces the teosinte-type of peduncle in which a subtending spathe remains about the maturing pistillate spike and, thereby, provides support in lieu of nodal parenchyma.

The features of the hollow rachis-segments of teosinte

[1] This type of longitudinal compression is sometimes referred to as condensation or telescoping.

EXPLANATION OF THE ILLUSTRATION

PLATE LV. 1, A drawing of a pair of pistillate spikelets and their associated cupule in maize. The cupule has lignified wings (*cw*) and the outer glumes have membranaceous wings (*gw*). The ovary and even the young caryopsis is usually enclosed by floral bracts. The inspiration for this drawing came from an illustration of a single pistillate spikelet in Häckel (1887). About eight times natural size.

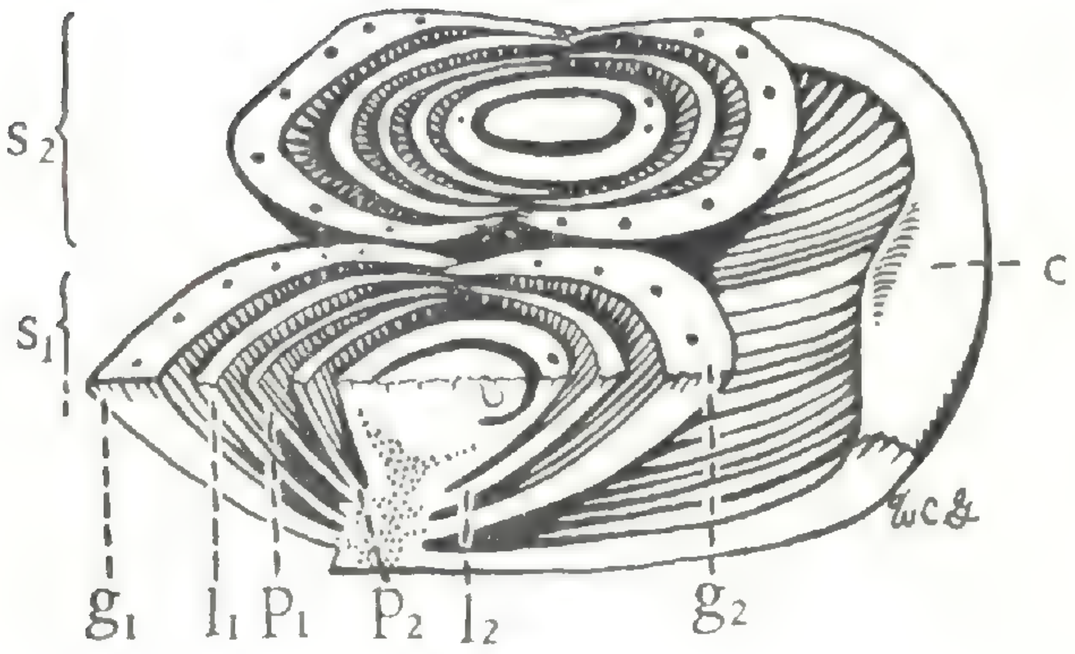
2, Vertical and cross-sectional views of the previous figure in order to facilitate labeling of parts. s_1, s_2, spikelet–1, spikelet–2; l_1, l_2, lemma–1, lemma–2; p_1, p_2, palea–1, palea–2; *c*, cupule. About four times natural size.

3, A portion of a maize cob with spikelets removed. The cupules occur in several alternate longitudinal rows. *r*, rachis; *cw*, cupule wing; *rb*, rachilla base. About three times natural size.

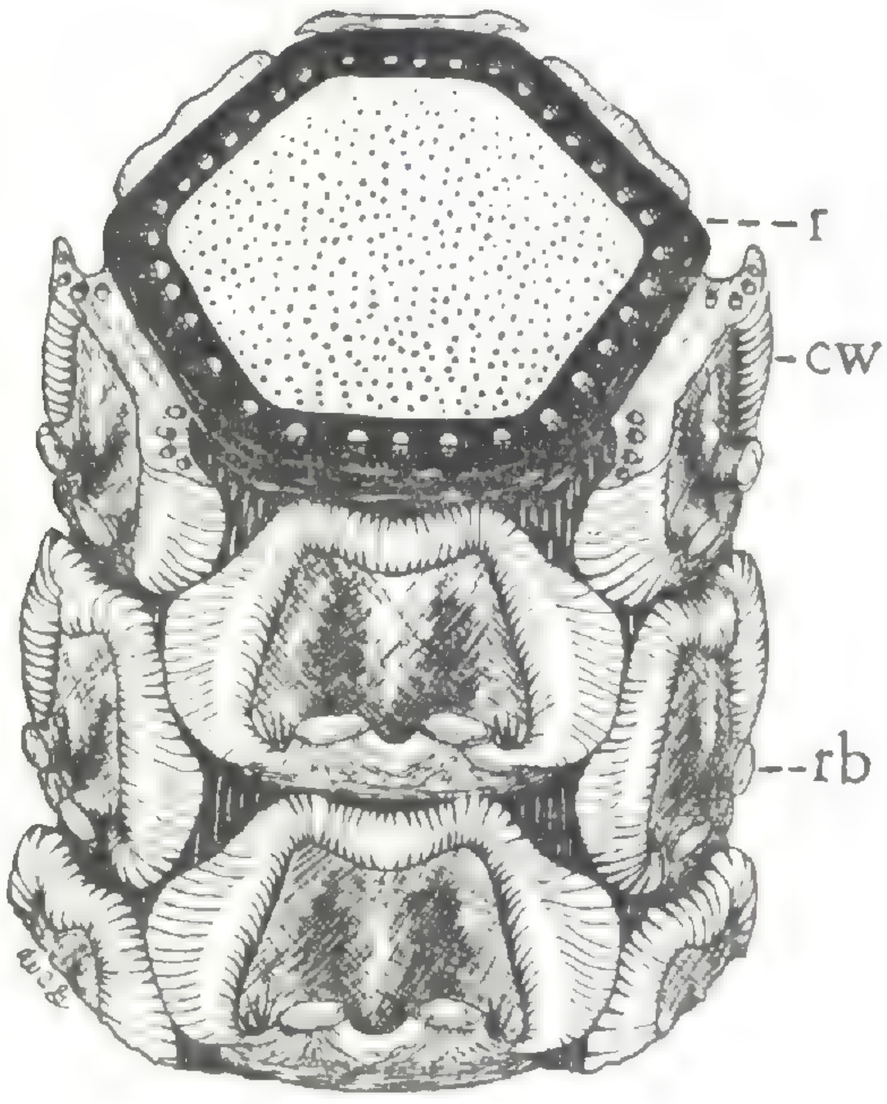
Drawn by WALTON C. GALINAT

Plate LV

1



2



3

and *Tripsacum* serve such highly useful purposes and, at the same time, resemble so closely the now functionless maize cupule, that the latter appears to be a rudimentary homologue of the former. For example, the lateral wings of the rachis-segment, which correspond to the "rachis-flaps" of the maize cupule, serve to clasp the outer glume of an enclosed pistillate spikelet and, in this way, complete the structure of the fruit case. Below the lateral wings there are hairy notches which have an identical counterpart in maize and which, in teosinte and *Tripsacum*, serve as openings for the entrance of water prior to germination and for the protrusion of the primary root during germination. The dense hairs in the notch exclude small insects from the enclosure and the high degree of lignification of both rachis-segment and outer glume perfect this structure as a protective device.

The homology between the cupulate rachis-segment of teosinte and *Tripsacum* and the cupule of maize can not be doubted, although there are usually slight differences in these structures. For example, the lining of the fruit-case cavity in teosinte and *Tripsacum* is frequently more highly lignified and less pubescent than that of the maize cupule. Such extreme lignification and reduced pubescence as are found in teosinte may also occur in the cupules of teosinte-contaminated maize or in vestigial glume (*Vg* gene) maize.

Nature of the Cupule in the American *Maydeae*

A consideration of the nature of the cupule in the American *Maydeae* will be centered on the cupule of maize, because it is more variable and amenable for experimental studies than its homologue in teosinte and *Tripsacum*.

Depressions in internodes. Compression of axillary buds against the adjacent young culm is known to be

responsible for the initiation of permanent grooves in the internodes of the vegetative axis (Arber, 1934; Anderson, 1949). Similarly, there is evidence that compression is a factor in the depression of rachis internodes. During early floral development in maize, the original branch primordia, each of which is the initial for a pair of pistillate spikelets, are compressed against the rachis with the plane of the branch diverging from the plane of the rachis at about a 45° angle (Kiesselbach, 1949, Fig. 38; Bonnett, 1940). Subsequent expansion of the differentiating spikelets without a corresponding elongation of the rachis-segments, forces the spikelets downward to a 90° angle, while a cupule appears in the rachis at their former resting place.

The role of compression in the formation of this cupule is revealed by the effects of certain genes in altering the usual scheme of ontogeny. Thus, when the pistillate rachis is free from compression during youth, as in the upper portion of the ears of certain tunicate varieties or corn-grass strains, then the cupules are shallow and the rachis-flaps are relatively inconspicuous. Also, the physical nature of the pistillate spikelets influences the depth of cupules. For example, if the spikelets are papery (papyrescent maize), the cupules are shallow and if the spikelets are borne singly (corn-grass maize), the cupules are narrow. But if, on the contrary, the spikelets are corneous and remain appressed to the rachis (as in certain highly "Tripsacoid" varieties), then the depressions are deep and the rachis-flaps are prominent.

The adnate prophyll. The cupule is more than just a depressed rachis-segment. Cutler and Cutler (1948) have noted that it seems to resemble a small confined leaf whose lateral auricles are the "rachis flaps" or cupule wings and the subtending auricle notches are the "hairy notches" of the cupule. More recently, Nickerson (1954)

has suggested that the cupule, including its rachis-flaps, represents a prophyll adnate to the rachis. Before proceeding with the evidence concerning Nickerson's suggestion, the prophyll itself, will be defined and described.

According to definition, the prophyll (*pro*–first ; *phyll*–leaf) is a leaf-like organ borne at or near the axil of every vegetative branch. It is characterized by two keels which lie adjacent to the margins of the main axis and by lateral wings which extend outward from each keel and clasp the branching shoot. In the case of the prophyll of an ear shoot in maize, these wings surround, overlap and sometimes fuse together at the base of the shank. When the wings are more narrow, as in vestigial glume maize, then pronounced lobes or auricles may appear at the base of each prophyll wing. The tissue between the two keels of the prophyll is much thinner and with fewer vascular bundles than that in the adjacent lateral wings.

Nickerson (1954) has pointed out that the cupule differs from the surrounding rachis in the orientation of a vascular system in its wings (rachis-flaps), in being often more pubescent and in having the capacity, in some cases, to be "peeled" from the rachis. Also, the cupule is often distinct from the rachis in being more highly lignified and sometimes of a different color. Color differences are especially conspicuous when midcob color is present. This characteristic was described by Demerec (1927) and was later shown to be at the *R* locus (Mangelsdorf, 1947). The *R*-midcob gene is responsible for a red or brown colored ring in the cob and a rind of corresponding color on the culm. In the cob the color extends from the colorless pith outward as far as, but not into, the cupules. On the barren faces between the longitudinal rows of cupules, the outer edge of this colored area appears directly upon the epidermis of the rachis. The same barren area becomes green when development occurs in direct sunlight.

All of the morphological evidence supports Nickerson's suggestion that the cupule (or, as proposed here, the lining of the cupule) represents a modified prophyll which is adnate to the pistillate rachis. It appears that a modification or elaboration of Sturtevant's original definition of a cupule is necessary. Hereafter, we shall consider that the cupule of maize consists of both a mechanical compression groove and a prophyll which is adnate to it. Likewise, we shall also consider that in teosinte and *Tripsacum* the homologue of the cupule also consists of a rachis-segment depression which is lined with an adnate prophyll. Furthermore, it is apparent that it is the adnate-prophyll part of the cupulate fruit case which perfects this unique protective device.

The pulvinus. If there are prophylls which are adnate to the pistillate inflorescence (ear) of maize, what is their role in the staminate inflorescence (tassel) which lacks cupules, and in the non-cupulate panicles of other grasses? It is suggested here that a homologue of the prophyll in non-cupulate inflorescences including the maize tassel is represented by the axillary pulvinus. These pulvini, which occur in most paniculate grasses, are hairy swellings which are located in the axils of the primary branches of the inflorescence. The homology of the pulvinus and the prophyll, as suggested above, is supported by the following observations on maize inflorescences.

(1) Pulvini and prophylls, either adnate or free, are mutually exclusive.
(2) A series of intermediates between prophylls adnate to the main axis and pulvini in the axils of the pedicels of the spikelets may exist in the terminal and partly pistillate inflorescences of tillers.
(3) The pulvinus is leaf-like in being a darker shade of green than the associated axis and is like the adnate-prophyll part of the cupule in shape, extreme hairiness and point of origin.

(4) When the lowermost tassel branch is modified as a husk-enclosed "sub-tassel ear," as described by Galinat (1954 *a*), then a prophyll replaces the usual pulvinus.

Prophyll development and the phytomer concept. Phytomer, as defined by Gray (1879), is a convenient term for describing the repetitious pattern which, in the grasses, consists of an internode, a leaf, a branch and a prophyll. When the vegetative phytomer is described in the order of maturation of parts, the leaf is placed at the top of an internode (Evans and Grover, 1940 and others). But in the inflorescence this order and the delimitation of the phytomer appear to be different (Galinat, 1954 *b*) in that the spathe or its rudiment which subtends solitary or paired spikelets is borne at the base of a disarticulated phytomer. The concept of the phytomer as a discrete evolutionary unit has been rejected by Arber (1934) and others, although the term itself does appear to have value in characterizing the homologies of corresponding parts when the fundamental design is modified during floral development.

In the floral phytomers[1] of most grasses, both spathes (subtending leaves) and prophylls have become either rudimentary or extremely modified except in the ultimate branches (florets) where the lemmas and paleas are their relics. The potentialities for complete development of all the parts in a floral phytomer remain, however, as is demonstrated by certain variations in the *Maydeae* and other tribes. For example, a homology between the lemmas and vegetative leaves is readily shown by the conversion of the latter into the former in short-day maize and other grasses, as a result of certain sequences of photoperiodic treatment (Galinat and Naylor, 1951) or other disturbances which produce inflorescence prolifera-

[1] The term "phytomer" will be used here only in a descriptive sense.

tion. The presence of rudimentary spathe initials subtending each pair of spikelets is revealed by certain mutant genes of maize (the corn-grass and teopod genes) which stimulate them into active development. Also these genes may cause development of a prophyll at the base of the spikelets when cupules are absent and, thereby, complete the phytomer (Galinat, 1954 *b*).

The fruit case of *Coix*, an Oriental relative of maize studied morphologically by Weatherwax (1926), represents the ultimate in functional development of the spathe part of a floral phytomer. In this grass the subtending spathes are well-developed as protective enclosures for individual pistillate spikelets, and a free prophyll, with its dorsal side adaxial to a slender non-cupulate rachis-segment, is borne at the base of each spikelet and within the spathe.

Evolution Preceding Cupule Formation

At the other extreme of the grass family, in certain *Bambuseae*, the floral phytomers may also be completely developed. In the bamboo genera of Bentham's subtribe I (and also in *Nastus*), Holttum (1956) found that "the branching of a spikelet tuft is exactly on the same pattern as the vegetative branching at the node of a bamboo culm" [in having a subtending bract and a prophyll at the base of every branch]; and he suggests further that in the more evolved grass panicles "the protective function of bracts and prophylls . . . is no longer needed [because of protection provided by leaf sheaths to the young inflorescence], and the disappearance of these structures is to be correlated with that fact."

It is probable that compression from tightly binding leaf-sheaths about young paniculate inflorescences was originally responsible for certain reductions and modifications within the floral phytomer. For example, the

space-consuming prophylls of some grass inflorescences seem to have been reduced to small pulvini; these structures were later specialized for use in spreading the panicle branches at maturation. Compression during early development may also cause the rachis-segments to arch away from the attachment points of the spikelets. This bending of the rachis-segment is especially apparent in the most primitive subtribe of the *Andropogoneae*, the *Saccharinae*. Here (*Erianthus coarctatus*) the inflorescence is a spreading panicle with hairy filiform rachis-segments bending away from paired spikelets (Plate LVI, fig. 1). Further compression and reduction is apparent in the subtribe *Rottboellineae*, where one can trace a graded series of types leading toward formation of the cupulate fruit case (Plate LVI, figs. 2, 3, 4), as was pointed out by Weatherwax (1935). In *Elyonurus tripsacoides* we find contraction to a spike, and proceeding to *Manisurus* spp. there is reduction to solitary spikelets. At this stage the rachis-segment becomes slightly thickened and depressed, and there is a tendency for pedicels to become adnate to it. For example, in *Hackelochloa* a shallow rachis-segment is made functionally deeper by the adnation of the pedicel from a staminate spikelet along the inner lateral edge of the rachis-segment. The spikelet is then appressed into the resulting cavity by its outer glume. In the specimens examined, *Manisuris tuberculosa* represented the closest approach to the structure of *Tripsacum*. *M. tuberculosa* has a more conspicuous pulvinus in the axil of each pedicel and a thicker rachis-segment than does *M. cylindrica*. Although *Manisuris*, of all the *Andropogoneae*, most closely resembles the American *Maydeae*, it differs from *Tripsacum* by having: (1) Perfect flowered spikelets, rather than unisexual ones; (2) Sterile pedicels which are remnants of the pedicellate spikelets of a pair, instead of the complete

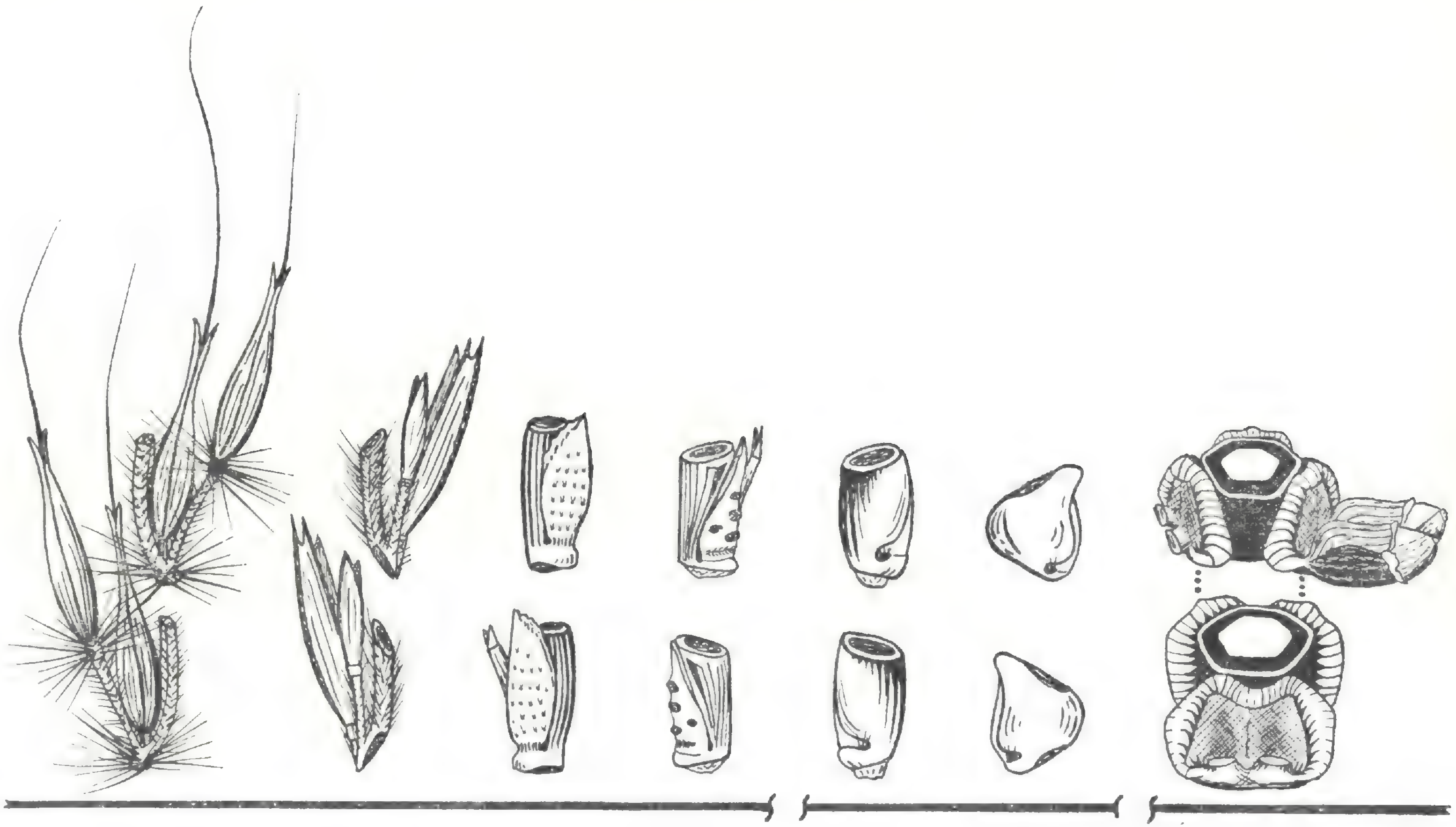


PLATE LVI. A series of types leading to formation of the cupulate fruit case. 1–4, *Andropogoneae*. 1, *Erianthus coarctatus* Fernald; 2, *Elyonurus tripsacoides* Humb. and Bonpl.; 3, *Manisuris cylindrica* Kuntze; 4, *Manisuris tuberculosa* Nash. 5–7, American *Maydeae*. 5, *Tripsacum dactyloides* L.; 6, *Euchlaena mexicana* Schrad.; 7, *Zea Mays* L. About two and one half times natural size. *Drawn by* WALTON C. GALINAT.

abortion of one; (3) Sculpturing of the outer pistillate glume, rather than a lack of sculpturing; (4) Small axillary pulvini, instead of adnate prophylls. The last distinction, the presence or absence of adnate prophylls, serves as a definitive character for separating the *Andropogoneae* from the American *Maydeae*. The usual taxonomic separation involves the presence of perfect flowers in the former and unisexual ones in the latter. But this character in these and other tribes tends to be equivocal.

Collins (1912) has pointed out the value of homozygous tunicate maize in demonstrating the close relationship of the American *Maydeae* to the *Andropogoneae*. Modern maize has been so modified by domestication, however, that we have turned to tunicate teosinte in order to determine if the series of compressions and reductions which occur in the *Andropogoneae* are an evolutionary extension of those which result in the cupulate fruit case in the *Maydeae*. The effect of the tunicate gene (*Tu*) of maize, when introduced by repeated backcrossing into teosinte, has been described by Mangelsdorf (1948). He states: "In tunicate teosinte the caryopsis is completely enclosed by prominent membranaceous glumes, and the rachis segment becomes nothing more than an appendage, playing no part in enclosing the caryopsis." More recently we have observed that the general structure of the fruit case in tunicate teosinte (or, more exactly, in half-tunicate teosinte) approximates a typical condition for the *Andropogoneae*. The resemblance is closest to the structure of *Elyonurus tripsacoides* of the subtribe *Rottboellinae*. In both cases the spikelets are borne in pairs along a slender, disarticulating rachis with slightly concave segments; the pedicellate spikelet is staminate (only in the distal portion of the tunicate teosinte spike), while the sessile spikelet is either perfect or pistillate; the floral bracts are long and herbaceous or unspecialized. The

slender rachis-segments of tunicate teosinte differ significantly from those of *Elyonurus* by the presence of a shallow non-functional adnate prophyll.

The similarities between tunicate teosinte and *Elyonurus tripsacoides* not only reflect the close relationship between the *Andropogoneae* and the American *Maydeae*, but also are suggestive of a single wild prototype of both maize and *Tripsacum* with its cupulate fruit case. Although the exact nature of wild maize is uncertain, the many recent studies on primitive archaeological maize suggest that the factors for an extremely compact, polystichous and continuous rachis represent acquisitions made chiefly during domestication. Other peculiarities of maize, such as the development of both pistillate spikelets of a pair rather than the complete abortion of one and the lack of sculpturing or extreme lignification in the outer glume, seem to place wild maize at an evolutionary point preceding both *Tripsacum* and *Manisuris* and similar to a type of *Elyonurus* with perhaps the addition of an adnate prophyll. Because of the uncertainty, however, in Plate LVI we have arbitrarily represented maize at the extreme end of the American *Maydeae* in order to present a continuous series of types leading to the formation of the cupulate fruit case. In order to facilitate the comparisons, the actual representation of maize shows a disarticulating type of rachis. Normally maize has a continuous rachis except in certain derivatives from maize-teosinte hybrids.

Evolution of the Outer Glume

Concurrent with the evolution leading to cupule development, the outer glume has undergone a corresponding degree of specialization toward affording increased protection. The structure of this glume has evolved from that of a long, herbaceous, leaf-like bract (*Erianthus* spp.)

to a shorter, coriaceous structure marked by various types of sculpturing (*Manisuris* spp.; *Hackelochloa* spp.) and, finally, to a highly lignified glume which is specialized in shape, texture and plane of divergence so as to bring about the closure of the narrow opening of a lignified prophyll which is adnate to a depressed rachis-segment. Various inherent modifications of this glume also occur in maize (Galinat, in press). In normal maize, it may be coriaceous in texture (many South American varieties) or, more commonly, it may resemble its counterpart in teosinte in being corneous or indurate (teosinte contaminated varieties from North and Central America).

Parallel Evolution in the *Hordeae*

The Hordeae series. The combination of a compact spike and a continuous rachis is rather frequent in the agriculturally important tribe, *Hordeae*. Here the spikelets are borne singly, although they are perfect and usually multiflowered. Occasional reductions within the spikelet and a thickening of the rachis have produced a parallel series leading to the formation of something approaching the cupulate fruit case. An outstanding difference between these series lies in the nature of the outer glume which closes the cavity in the rachis. In the *Andropogoneae* and *Maydeae*, the enclosure is completed by the first glume; while in the *Hordeae* (*Lolium* and *Monerma*), the spikelet is placed in the opposite direction so that the second glume is outermost.

Of the five successive stages representing the *Hordeae* series (Plate LVII, figs. 1–5), only the end result (*Monerma cylindrica*) has progressed beyond a type suitable for culture as a grain plant. Two of the other genera (*Agropyron* spp. and *Aegilops* spp.) are thought to have contributed directly to the evolution of the genus *Triticum* and so to the development of the bread wheats.

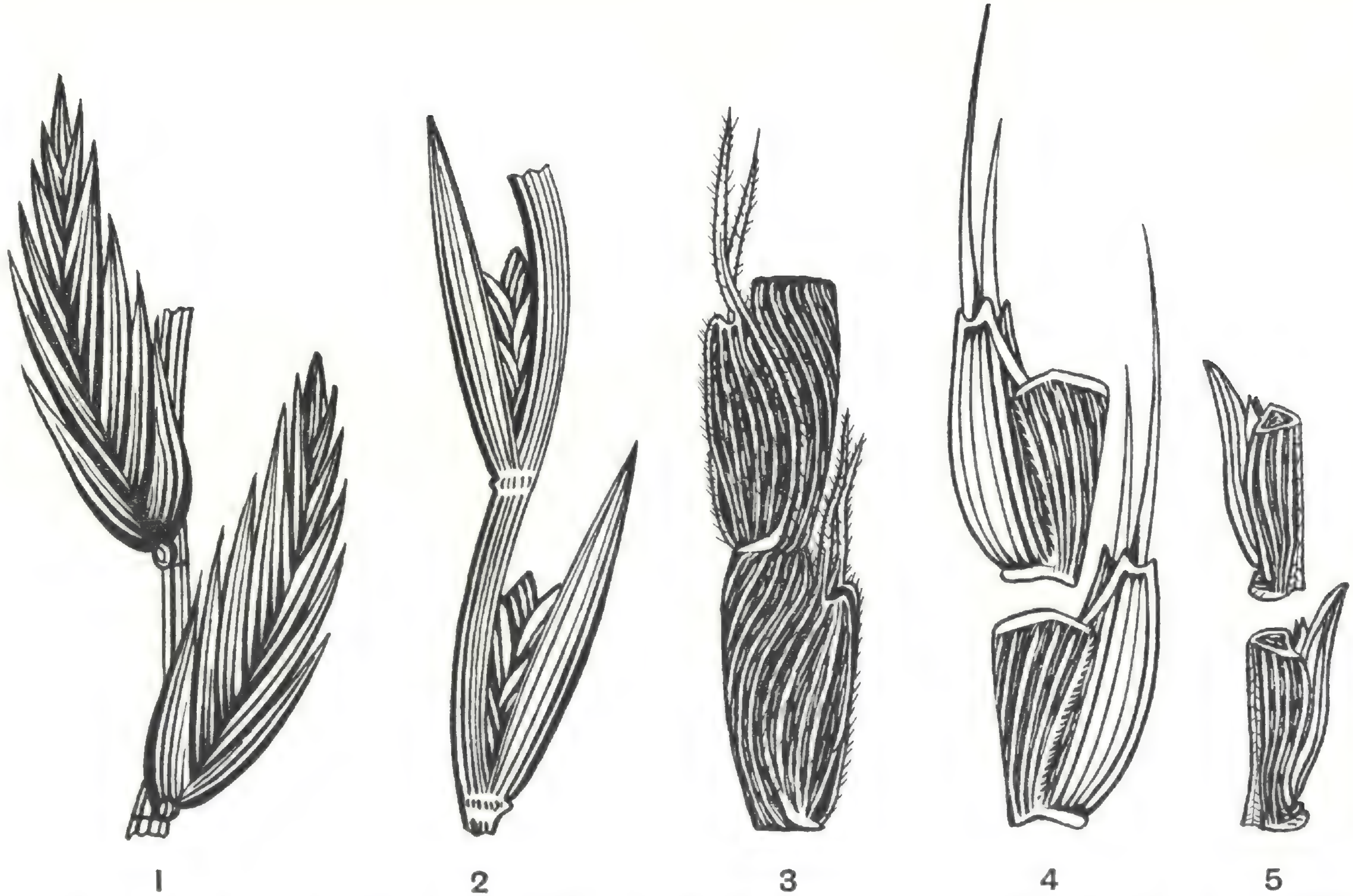


PLATE LVII. Parallel evolution in the *Hordeae*. 1, *Agropyron Smithii* Rydb. 2, *Lolium subulatum* Vis. 3, *Aegilops* (*Triticum*) *cylindrica* Host. 4, *Triticum monococcum* L. 5, *Monerma cylindrica* Coss. and Dur. About five times natural size. *Drawn by* WALTON C. GALINAT.

The remaining one (*Lolium* spp.) is one of the oldest domesticated pasture grasses. A brief description of the changes which occur in the *Hordeae* series follows:

1. *Agropyron Smithii* Rydb. This species, which has a compact spike bearing multiflowered (6 to 10) spikelets, is typical of the *Hordeae*. The bilateral plane of the rachilla is placed at a right angle to the bilateral plane of the rachis. Thus, both ranks of florets are apparent. The rachis is slender and continuous with no suggestion of either grooving or cupule development.

2. *Lolium subulatum* Vis. Here the spikelets have turned edgewise and, in youth, become tightly compressed against the rachis (as is evidenced by a reduction of the inner (first) glume, except in the terminal spikelet where it is free to develop). The outer (second) glume elongates and conceals dorsally its spikelet against the rachis.

3, 4. *Aegilops* (*Triticum*) *cylindrica* Host. and *Triticum monococcum* L. These species do not fit into the series perfectly in that their spikelets are placed as in *Agropyron*. They do, however, have pronounced cupuloid cavities in the rachis-segments, especially in *Triticum*, where the cavity lining is pubescent and the lateral wings are conspicuous in having subtending notches.

The rachis of *Aegilops* is continuous or tardily disarticulating. This character is recessive to the disarticulating rachis of its relative, wild emmer (*Triticum dicoccoides*) and is thought to have been later transferred during the development of wheat spikes suitable for agricultural harvesting (Percival, 1926). The presence of a continuous rachis here, and in many of the other *Hordeae*, as well as in maize of the previous series, is basic in making these grasses of agricultural importance.

5. *Monerma cylindrica* (Willd.) Coss and Dur. In this species solitary, uniflowered spikelets are embedded

in deep cavities along the rachis. The general appearance is superficially similar to that of *Tripsacum floridanum*. There are so many differences between *Tripsacum* and *Monerma*, however, that there can be no doubt that the resemblances are a result of parallel evolution. The rachis cavity of *Monerma* is closed by the second glume (instead of the first), is longer than a rachis-segment (instead of confined within it), lacks hairy notches on either side of the outer glume and lacks the nodal parenchyma which connects the rachis-segments in *Tripsacum*. The outer glume of *Monerma*, as well as the associated rachis groove, extends up into the next rachis-segment and, in this way, holds the spike together during the final stages of maturation. There is a scar which projects upward from the apex of the cavity to the node above. This scab or scar is identical to the surface of the cavity below in being indurate and in having a glossy-yellow color, as compared to the surrounding rachis which is herbaceous and green. This depression does not appear to be associated with a prophyll-like structure and is probably mechanical in origin. At least compression of the spikelet against the rachis-segment has caused suppression of the inner glume and apparently also suppression of any adjacent prophyll primordia.

Other grasses. Other examples of rachis cavities, obviously of a mechanical origin, are found in isolated species (*Paspalum fluitans* (Ell.) Kunth and *Stenotaphrum secundatum* (Walt.) Kuntze).

Discussion

The cupulate rachis-segment, which is basic to the type of fruit case in teosinte and *Tripsacum*, appears to be, in part, the ultimate product of several evolutionary trends affecting the inflorescence and, thereby, the protection of the caryopses. These general tendencies have

been recognized previously. Bews (1929) has pointed out that, in general, the spreading type of panicle is the most primitive and "Starting from this, the main evolutionary trend has been towards contraction, condensation [or compression], reduction and, as a result, increased protection." Arber (1934) has added that "With the consequent compression [from confinement during youth], we may, in some degree, associate the reduction within the inflorercence [or within the floral phytomer], which is so conspicuous in the grasses."

These evolutionary trends are apparent in a graded series of species starting with the *Andropogoneae* and terminating with the American *Maydeae* as follows: The spreading panicle of grasses such as *Erianthus* have contracted to compact spikes as in *Tripsacum* along with various reductions: in sex development (perfect to unisexual); in numbers of spikelets (paired to single); in glume length (long to short); and in degree of pubescence (hirsute to glabrous). The last named feature may be, in part, related to an increase in lignification and a decrease in cell size, as suggested by preliminary studies in maize. Coincident with these reductions, the rachis-segments enlarge in diameter and an adnate prophyll develops on the inner surface of the concave segment. The wings of the prophyll protrude laterally so that they clasp the outer glume of the enclosed spikelet and, thereby, complete the structure of this protective device. This adnate prophyll constitutes a distinguishing feature between the caryopsis-bearing inflorescences of the *Andropogoneae* and the American *Maydeae*. In the staminate inflorescence of maize and teosinte, and in other non-cupulate panicles, the prophyll appears to be modified as a small axillary pulvinus. Cupules are weakly developed in the staminate rachis of *Tripsacum*.

The *Hordeae* contain another independent series lead-

ing to the formation of a concave rachis-segment type of fruit case. The similarity of end products in these two separate lines of evolution results from parallel tendencies for contraction, compression and reduction. The final product in the *Hordeae* series (*Monerma cylindrica*), does not quite approach the ultimate state of perfection as a protective device which is found in the American *Maydeae*, because it lacks the increased protection provided by the lateral wings of an adnate prophyll. Thus, *Monerma* is more similar to *Manisuris* than it is to *Tripsacum*.

Acknowledgments

During the preparation of the manuscript, many helpful suggestions were made by Professor P. C. Mangelsdorf of Harvard University and Professor E. Hernandez X. of the National School of Agriculture, Mexico. Specimens of the *Gramineae* in the Harvard University Herbarium were utilized for this study.

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A NEW METHOD OF COCA PREPARATION IN THE COLOMBIAN AMAZON

BY

RICHARD EVANS SCHULTES

COCA, the well-known narcotic elaborated from the leaves of *Erythroxylon Coca* Lam., is used over a wide area in the Andean highlands of southern Colombia, Ecuador, Peru and Bolivia, in parts of the western Amazonia and in certain isolated regions such as the Sierra Nevada de Santa Marta in northernmost Colombia. The manner of using coca differs appreciably in each of these areas, and, even within a given area, coca-chewing often varies somewhat from locality to locality.

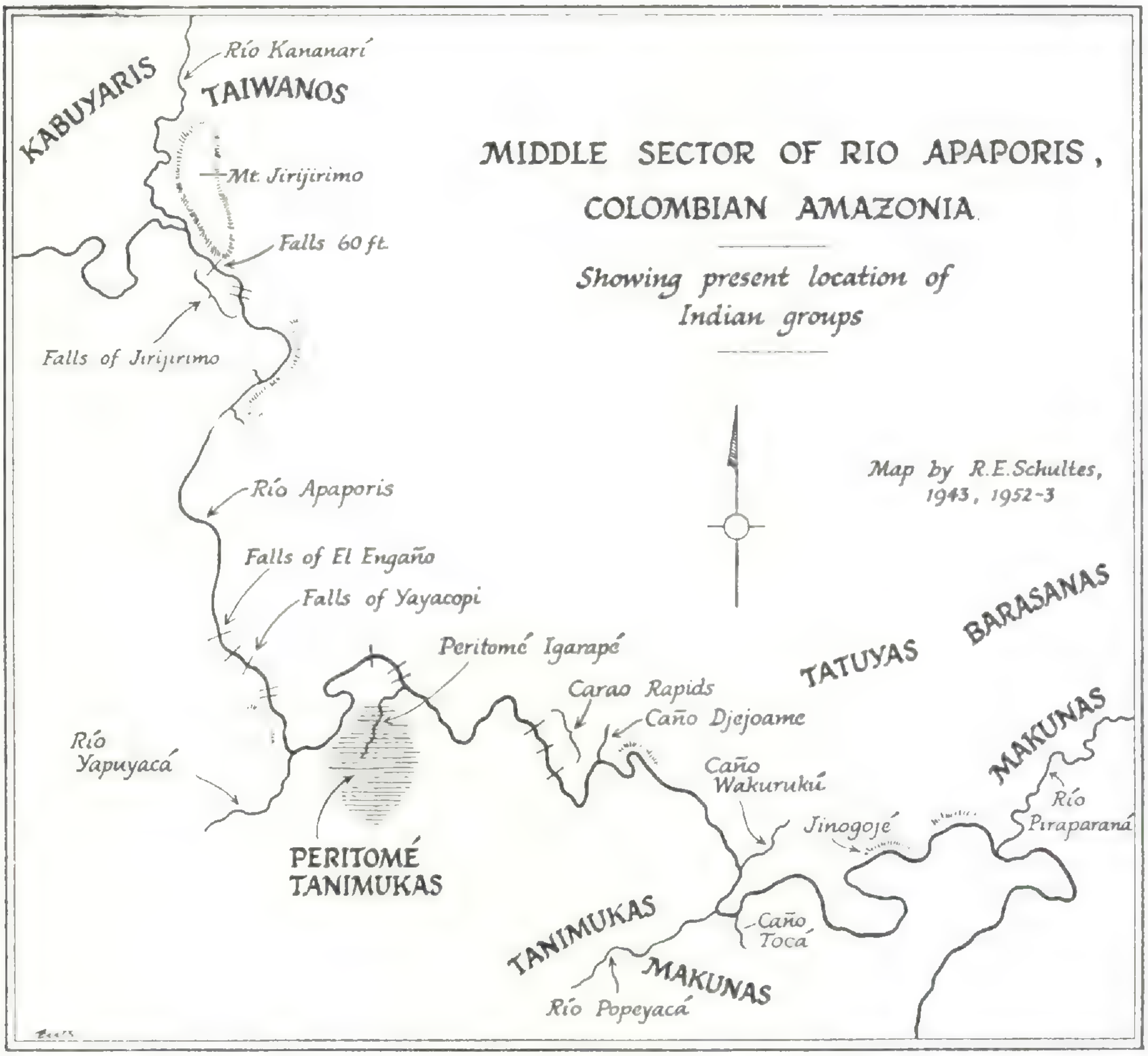
Curiously, the preparation and use of coca in the Amazonian parts of Colombia vary very little, if at all, from tribe to tribe. Quite in contrast to the method of use common throughout the Andean highlands, where dried, whole leaves of the plant are chewed with alkali quids of diverse origins, the method throughout the forested northwest Amazon requires the toasting and pulverization of the leaves. Into the resulting fine, green powder is thoroughly mixed as an alkaline component the finely sifted ashes of the leaves of any of several species of *Cecropia* or of *Pourouma*, usually *P. cecropiaefolia* Mart. The final powder is pale greenish, often with a slight greyish hue, and, when fresh, has a flavor which is not at all unpleasant.

The Indians of the Colombian Amazon take this dry powder into the mouth and, with the tongue, slowly work the gradually moistening mass until it is packed between the cheek and the gums. The slow "dissolving" and swallowing of the coca-ash mixture induces the desired narcotic effects and, in many ways, is much pleasanter and more satisfactory than the highland method of chewing harsh, dried leaves with lime pebbles or other alkaline agents.

For many years, I had studied the preparation and use of coca in eastern Colombia and had experimented with it myself over long periods. The similarity of its preparation over such a wide area was rather monotonous. In March 1952, however, I encountered the only major difference in coca-making which ever came to my attention during my more than a decade of travel through the region. It was as unexpected as it was novel. Even Koch-Grünberg, whose ethnological work in the region is classic, fails to report this method of coca preparation (Koch-Grünberg, Theodor: "Zwei Jahre unter den Indianern" 1 (1909); 2 (1910). Neither does the most recent and most thorough study of coca in Colombia (Uscategui Mendoza, Nestor: "Contribución al estudio de la masticación de las hojas de coca" in Rev. Col. Anthrop. 3 (1954) 209-289) consider it. Since it seems not to have been reported, it will be described in detail as a contribution to our growing understanding of the narcotics of South America.

In the very headwaters of the Igarapé Peritomé, a small creek on the right bank of the Río Apaporis into which it empties slightly downstream from the great falls known as the Cachivera de Yayacopi or Raudal de La Playa, there is a small group of Tanimuka Indians living entirely detached from the main body of the tribe on the Río Popeyacá to the east (See map). This group,

numbering now only twenty-five or thirty, apparently fled to hiding in this remote spot more than a quarter of a century ago rather than submit to enforced labor in the balata-forests.



It would seem that these isolated Tanimukas hold a monopoly on this unusual method of coca-making. Whether it is a recent innovation of their own or whether it represents a once more widespread culture-trait surviving only in this small band we cannot declare. All that I can state with certainty is that the custom is not practiced amongst any of the other coca-using tribes of Amazonian Colombia, not even in the main group of Tanimukas. It is worthy of note, nevertheless, that the

Tanimukas of the Popeyacá, as well as Yukunas, Makunas and other neighboring peoples, occasionally journey to the Peritomé Tanimukas, especially immediately prior to important dances or festivals, to purchase large supplies of the Peritomé coca. And this has continued apparently for many years, notwithstanding the fact that the necessary plant ingredients are to be found abundantly throughout the whole area.

The refinement, if it may be so termed, to which I refer lies in the use of the resin of *Protium heptaphyllum* March. in the coca-ash mixture.

Long and slender tubes or "cigarettes" of rolled and partly dried leaves of *Ischnosiphon* are tamped half full with small lumps of the whitish resin. The tip of that part of the "cigarette" containing the resin is lighted and brought to a glow by a gentle blowing through the tube.

In the meantime, several armfuls of dried leaves of *Cecropia* are set afire on the earth floor of the house and reduced to ashes. The ashes are then scraped together into a small, more or less conical pile. Before the ashes are completely cooled, several Indians with resin-tubes insert the glowing ends of the tubes into sundry places in the ash-pile and blow vigorously. The balsamic incense or smoke from the glowing resin permeates the ashes. This process, which fills the house with a pleasant myrrh-like aroma, continues for seven or eight minutes or until most of the resin in the tubes is spent.

The ashes are then collected, sifted through a piece of fine, pounded bark-cloth and added to an equal amount of pulverized and sifted coca powder. The product is then ready for use.

The presence of the incense from *Protium*-resin alters appreciably the usual characteristic taste of coca, giving it a balsamic savor. There is no evidence, however, that

this addition either heightens or lessens the normal narcotic effects of coca prepared in the manner customary throughout the northwest Amazon. It would seem to be obvious that the only effect sought is a change in taste.

Thoroughly accustomed though I was to the use of coca at this time, I found that the resin-treated product usually caused irritation of the mouth and throat the first day of its use. This irritation, due undoubtedly wholly to the balsamic smoke absorbed by the ash-particles, disappeared upon continued use of the coca.

Enquiry indicated that the resin of *Protium heptaphyllum* is the only one of the many balsamic exudations of the forests considered to be suitable for flavoring coca. According to Indian custom, resin for this purpose is gathered exclusively from old trees of *Protium heptaphyllum*, but no "explanation" for avoidance of younger trees was offered. Incisions are made in the bark of the trees, and the resin is allowed to dry on the trunk before being gathered and wrapped up in leaves into little packets which are hung under the rafters of the house to "age" for four or five months before using.

The genus *Protium*, belonging to the Myrrh Family or Burseraceae, has given several resins to commerce and medicine, and the resins of allied genera have likewise enjoyed economic importance. Several species of *Protium* from northern South America have been of value as medicinal plants, but they are no longer so employed in the United States.

The resin from *Protium heptaphyllum*, a species widespread in South America, is usually referred to in Colombia as *brea* or *pergamín*, but it is known commercially as *tacamahaca* gum. These vernacular names, however, may also be applied to the resins of other burseraceous plants. This species yields a hard, translucent, white resin which easily fractures and which is distinctly pungent

even when old and dried. The properties of *tacamahaca* are similar to those of other terebinthinates. Its most important use at the present time is as an incense in churches. Some is exported to the United States from Brazil for use in the lacquer industry (Tschirch, A. and E. Stock: Die Harze 2, pt. 1 (1935) 339). While the fragrance of *brea* is exceedingly strong, the report that "where this tree grows, the air in the vicinity seems pleasant and wholesome from the incense-like resin that drops from any wound in the bark and collects in masses on the ground" (Record, S. J. and R. W. Hess: Timbers of the New World (1943) 109) would seem, at least insofar as my own field experience has taught me, to be rather an exaggeration.

Chemically, the resin of *Protium heptaphyllum* is made up of 30 per cent protamyrine, 25 per cent proteleminic acid, 37.5 per cent proteleresin as well as several minor constituents such as oil (Wehmer, C.: Die Pflanzenstoffe, ed. 2, 2 (1931) 651).

Carañna, known also as *gum caranna* or *Brazilian elemi*, is the product of a closely allied species, *Protium Carana* March. It has a balsamic odor only when fresh, and it is bitter to the taste. The dried resin is usually grey or blackish grey and translucent, and it fractures with a very lustrous break. It apparently is not employed in the preparation of coca. Its other uses are, in general, similar to those of the resin from *Protium heptaphyllum* and oftentimes the two are not distinguished by native peoples.

THE GENUS *QUARARIBEA* IN MEXICO AND THE USE OF ITS FLOWERS AS A SPICE FOR CHOCOLATE

BY

RICHARD EVANS SCHULTES

I. TAXONOMIC NOTES ON QUARARIBEA

THE taxonomic history of *Quararibea* is complex. The genus has been united with *Matisia*, with *Myrodia*, with both *Matisia* and *Myrodia*, and kept distinct by the numerous botanists who have treated the group.

De Candolle (Prodr. 1 (1824) 477) joined *Quararibea* and *Myrodia* but kept them separate from *Matisia*. Endlicher (Gen. Pl. (1836–40) 992) followed the same disposition of these genera.

Baillon (Hist. Pl. 4 (1873) 155) reduced *Matisia*, *Matisiopsis*, *Myrodia*, *Lexarsa*, *Gerberia* and *Myrodiopsis* to synonymy under *Quararibea*.

K. Schumann's treatment (in Natürl. Pflanzenfam. 3, 6 (1895) 64) united *Myrodia* with *Quararibea* and excluded *Matisia*. Basing his work on that of Baillon (in Adansonia 10 (1873) 146), he differed from Baillon only in the exclusion of *Matisia*. He divided *Quararibea* into two sections on the basis of the disposition of the anthers:

Section I: *Euquararibea* Baillon — Anthers disposed in a circle on the apical part of the staminal column or on the upper quarter of the column.

Section II: *Myrodia* (Swartz) Baillon — Anthers disposed only at the apex of the staminal column.

Vischer (in Bull. Soc. Bot. Genève, ser. 2, 11 (1919) 199) followed Baillon in uniting *Matisia* and *Myrodia* under *Quararibea*, including *Matisia* as a subgenus of *Quararibea*.

He offered an apparently far more fundamental subgeneric classification of *Quararibea*[1] than that proposed by Schumann. It was based on the structure of the ovary and the appearance of the staminal column.

Subgenus I : *Archiquararibea* Vischer—Ovary 2-locular; staminal column obsoletely 5-dentate or shortly 5-fid.

Subgenus II: *Lexarza* (Llave) Vischer emend.—Ovary 4-locular; staminal column apically dilated, 5-dentate.

Subgenus III: *Matisia* (Humboldt & Bonpland) Vischer—Ovary 5-locular; staminal column profoundly 5-fid.

In 1948, Cuatrecasas (in Lloydia 11 (1948) 185) considered *Matisia* as a synonym of *Quararibea*. Six years later, however, he (in Rev. Acad. Col. Cienc. 9 (1954) 175) outlined the results of more intensive study of these groups and concluded that *Matisia* and *Quararibea* should be maintained as distinct concepts.

García-Barriga (in Mutisia 2 (1952) 1) indicated that he accepted *Quararibea* and *Matisia* as the same and made several nomenclatural transfers from *Matisia* to *Quararibea*.

For reasons which I consider in detail below, I believe that *Matisia* should be retained as a distinct generic concept, even though not all of the plants which are or have been referred to *Matisia* may belong to it. Since I am excluding *Matisia*, I have not included a bibliographic history of it in this paper.

[1] Two of the three Mexican species of *Quararibea* (*Q. verticillaris* (DC.) Vischer and *Q. Fieldii* Millspaugh), fall into the subgenus *Archiquararibea*, and one (*Q. funebris* (Llave) Vischer), falls into the subgenus *Lexarza*. Indeed, the latter subgenus consists only of this one species.

The genus *Quararibea* (exclusive of *Matisia*) includes about twenty-nine species. These species show a wide range of variation with all conceivable intergrades. The differences which are exhibited, moreover, are so extensive that Bentham and Hooker included *Myrodia* (now considered to represent *Quararibea*) in the *Sterculiaceae* and *Quararibea* in the *Malvaceae* (inclusive of the *Bombacaceae*).

Quararibea is a widespread genus of tropical American trees and shrubs, occurring in Middle America, the West Indies and the northern part of South America. It is at once characterized by a peculiarly pungent, aromatic odor suggestive of slippery elm (*Ulmus rubra* Muhl.). This odor is present in every species and may be valuable in generic identification.[1] Most botanists who have considered *Quararibea* have remarked about its pungent fragrance. Endlicher (*loc. cit.*), for example, stated that the genus consists of "arbores v. frutices Americanae tropicae, odore aromatico gravi, tenaci . . . ."

The fragrance is strongest and most noticeable in the flowers, but it is also characteristic of the fruit. Other parts of the plant, as well, are reported to contain the aromatic principle. Standley (in Field Mus. Nat. Hist. 3, pt. 3 (1930) 354) called attention to the fact that the foliage of a Yucatan species has the "odor of slippery elm." In an article on the woods of the American bombacaceous plants, Record (in Trop. Woods 59 (1939) 19) made the statement that in *Quararibea* "The leaves and bark, at least in certain species, have a peculiar odor variously described as resembling curry powder, fenugreek (*Trigonella foenumgraecum* L.), inner bark of Slippery Elm (*Ulmus fulva* Michx.), or licorice." In addition to the flowers, fruit, foliage, and bark, the wood also has been reported sometimes to possess the pungent

[1] The name *Myrodia* is from the Greek, meaning "scent of myrrh."

fragrance. Of the wood, Record (*loc. cit.*) reported: "Tasteless and generally odorless, sometimes with characteristic scent of the bark and leaves."

The odor of *Quararibea* is extremely persistent. I have had an opportunity to examine several specimens which were collected in Mexico by Liebmann in 1841—more than a century ago. The fragrance from these specimens is but slightly weaker than that from herbarium material collected in the past twenty years.

Matisia is very closely related to *Quararibea*. Vegetatively, the two genera have many points of resemblance, although there are rather sharply distinguishing differences. The fact that the ovary is rather consistently 5-locular, however, would seem to indicate a fundamental difference between *Matisia* and the 2- or 4-locular *Quararibea*. Furthermore, another conspicuous difference is the entire lack in *Matisia* of the characteristic odor of *Quararibea*. This is true of all of the herbarium specimens of *Matisia* which I have had occasion to examine. It has been stated that all of the members of the genus lack it. Although Baillon did not consider the odor to be a character of significance, he made mention of the absence of it from his section *Matisia* of the genus *Quararibea*. He wrote (*loc. cit.* 147): "Je ne parle pas . . . de l'odeur de Mélitot, mais qui n'a pas, paráit-il, été constatée dans les *Matisia*, mais qui pourrait être plus ou moins fugitive ou qui ne serait pas, en tout cas, un caractère d'une importance absolue." Similarly, Triana and Planchon (in Ann. Sci. Nat. ser. 4, 17 (1862) 324), in discussing the fragrance of dried specimens of *Myrodia Cacao* Triana & Planchon, stated that "c'est l'ordinaire pour ce genre, une odeur très prononcèe de Mèlitot, laquelle manque absolument a tous nos *Matisia*."

Record (*loc. cit.* 15) points out that there are differences of a minor nature between the woods of *Matisia*

and *Quararibea*. These, however, are not of a fundamental character, and he names three species, now referred to *Matisia*, which are inseparable from *Quararibea* on the basis of wood structure alone. Record and Hess (Timbers of the New World (1943) 96) have maintained the two genera as distinct.

In consideration of the differences in structure of the ovary, of the absence of the characteristic odor of *Quararibea*, and of the presence of minor and variable vegetative differences, I believe that *Matisia* is best maintained as a distinct genus.

Quararibea *Aublet* Pl. Guian. 2 (1775) 691—Scopoli Introduct. (1777) n. 1297—Aublet in Cavanilles, Diss. 3 (1785–1790) 175, t. 71, fig. 2—Poiret in Lamarck, Encycl. 6 (1804) 22; *ibid.*, Suppl. 4 (1816) 636—De Candolle Prodr. 1 (1824) 477—Bentham & Hooker Gen. Pl. 1 (1867) 212—Baillon Hist. Pl. 4 (1873) 155—Baillon in Adansonia 10 (1873) 146—K. Schumann in Martius Fl. Brasil 12, 3 (1886–1892) 240—K. Schumann in Natürl. Pflanzenfam. 3, 6 (1895) 64–65)—Standley in Contrib. U.S. Nat. Herb. 23, 3 (1923) 787—Britton & Wilson Sci. Surv. Porto Rico & Virgin Islands, 5, 4 (1924) 569—Standley in Contrib. U.S. Nat. Herb. 27 (1928) 260—Standley in Field Mus. Nat. Hist. Bot. Ser. 3, 3 (1930) 354—Standley in Field Mus. Nat. Hist. Bot. Ser. 10 (1931) 278—Standley in Field Mus. Nat. Hist. Bot. Ser. 12 (1936) 251—Williams in Field Mus. Nat. Hist. Bot. Ser. 15 (1936) 316—Standley in Field Mus. Nat. Hist. Bot. Ser. 18, 2 (1937) 683. TYPE SPECIES: *Quararibea guianensis* Aublet.

Lexarza Llave in Llave & Lexarza Nov. Veg. Descr. 2 (1825) 7. TYPE SPECIES: *Lexarza funebris* Llave.

Myrodia Swartz Prodr. (1788) 102—Schreber in Linnaeus Gen. Pl. (1789) 472—Swartz Fl. Ind. Occ.

(1800) 1225)—De Candolle Prodr. 1 (1824) 477—St. Hilaire Fl. Brasil mer. 1 (1824) 208, t. 53—Endlicher Gen. Pl. (1836–1840) 991–992—Grisebach Fl. British West Indies (1864) 88—Hemsley Biol. Centr.-Am. Bot. 1 (1879–1888) 127—Bentham in Journ. Proc. Linn. Soc. Bot. 6 (1862) 115—Triana & Planchon in Ann. Sci. Nat., s. 4, 17 (1862) 324–328—Bentham & Hooker fil. Gen. Pl. 1 (1867) 219—Pittier Prim. Fl. Costaric. 2, 1 (1898) 49—Conzatti Gen. veg. mex. (1903) 128. TYPE SPECIES: *Myrodia turbinata* Swartz.

Quararibea funebris (*Llave*) *Vischer* in Bull. Soc. Bot. Genève, s. 2, 11 (1919) 295—Standley in Contrib. U.S. Nat. Herb. 23, 3 (1923) 787—Bakhuisen van den Brink in Bull. Jard. Bot. Buitenzorg, s. 3, 6, 2 (1924) 209—Standley & Calderón List. Pl. El Salvador (1925) 148—Standley in Field Mus. Nat. Hist. Bot. Ser. 12 (1936) 251—Standley in Field Mus. Nat. Hist. Bot. Ser. 18, 2 (1927) 683.

TYPE: Collected at Izucar, Puebla, under the direction of Guadalupe Victoria, President of Mexico. Apparently not extant.

Lexarza funebris Llave ex Llave & Lexarza Nov. Veg. Descr., 2 (1825) 7—León in Ximénez Cuatr. Libr. Nat. (1888) xlix.

Myrodia funebris (Llave) Bentham in Journ. Proc. Linn. Soc. Bot. 6 (1862) 115—Hemsley Biol. Centr.-Am. Bot. 1 (1879–1888) 127—Pittier Prim. Fl. Costaric. 2, 1 (1898) 49—Ramírez & Alcocer Sin. vulg. cient. pl. mex. (1902) 11, 107—León in Sahagún Hist. cos. Nueva España 3 (1938) 348.

SPECIMENS EXAMINED:[1]

Specimens referable to Quararibea funebris:

L. H. Bailey 555, March 19, 1940, Oaxaca (flowers purchased in market in Oaxaca City) (EH); *Conzatti 16*, December 7, 1895, Vera

Cruz (G); *Conzatti s.n.*, March 1940, Oaxaca (EH); *Karwinski s.n.* (photograph of the specimen in Berlin), Oaxaca (G)[2]; *Liebmann 429*, Oaxaca (?) June 1841 (F, US); *Llave s.n.* (photograph of the specimen in Geneva) Mexico (possibly Oaxaca) (F, EH, S); *C. D. Mill* (?) *s.n.*, "Cazones, Mexico," October 20, 1923 (NY); *Popenoe 744*, November 28, 1916, Guatemala (US); *Schultes 843*, June 1939, Oaxaca (150 flowers purchased in market in Oaxaca City) (EH); *Schultes & Reko 493*, August 1938, Oaxaca (50 flowers purchased in Oaxaca City) (EH); *Skutch 1846*, December 5, 1935, Guatemala (US).

Sterile specimens probably or possibly referable to Quararibea funebris:

Cook & Griggs 489, April 7, 1902, Guatemala (U.S.); *Williams 8928*, February–March 1937, Vera Cruz (F).

Specimens filed hitherto in herbaria as (but now excluded from) Quararibea funebris:

Brenes 19247, July 21, 1934, Costa Rica (F); *Heyder 2*, 1927, British Honduras (U.S.); *Record & Kuylen H66*, February 16, 1927, Honduras (NY, US); *Renson 318*, El Salvador (US); *Schipp 407*, October 15, 1929, British Honduras (A, F, G, M, NY, US); *Standley & Valerio 46611*, January 10–31, 1926, Costa Rica (US); *Williams 8500*, March 1937, Vera Cruz (F, M); *Williams 8317*, March 1937, Vera Cruz (F, US).

SPECIMENS NOT EXAMINED BUT CITED IN THE LITERATURE:

Andrieux 512, Oaxaca (B, K); *Hayes s.n.*, San Salvador (K); *Liebmann s.n.*, Vera Cruz (K).

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[1] Abbreviations used for herbaria represent:

A Arnold Arboretum, Harvard University
B British Museum (Natural History)
EH Economic Herbarium of Oakes Ames, Harvard University
F Field Museum of Natural History
G Gray Herbarium, Harvard University
K Royal Botanic Gardens, Kew
M Missouri Botanical Garden
N New York Botanical Garden
US United States National Herbarium, Smithsonian Institution

[2] Photographs of this Karwinski collection have erroneously been designated in American herbaria as representing the type of *Myrodia verticillaris* [Moçiño & Sessé] ex de Candolle. It is not a type specimen. Furthermore, it is referable to *Quararibea funebris*.

VERNACULAR NAMES:

cacahuaxochitl; cacaoxochitl; cacauaxochitl; canela; flor de cacao; madre de cacao; rosa de cacao; rosita de cacao; tepecacao.

Quararibea funebris occurs in Mexico (Puebla, Vera Cruz and Oaxaca) and Guatemala. Its range has erroneously been stated to include British Honduras, Honduras, Costa Rica and El Salvador. This extension of range is attributable to the misidentification of specimens from these countries. Many of the specimens which have been referred to *Quararibea funebris* are sterile; those which are fertile are often only in fruit. Fortunately, however, it is not difficult to ascertain whether or not a fruiting specimen represents *Quararibea funebris*, for this species is the only reputedly 4-locular member of the genus, the others having two locules. The following collections: *Brenes 19247* (Costa Rica), *Heyder 2* (British Honduras), *Record & Kuylen H66* (Honduras), *Renson 318* (El Salvador), *Schipp 407* (British Honduras), and *Standley & Valerio 46611* (Costa Rica) have been responsible for the erroneous extension of the range of *Quararibea funebris* southeast of Guatemala. None of these collections can be referred to *Quararibea funebris*. Hemsley (Biol. Centr.-Am. 1 (1879–1888) 127) has cited a collection (*Hayes s.n.*) from San Salvador as representing *Quararibea funebris*, but it would appear to represent another species. The species concepts of *Quararibea* have been poorly understood and very loosely applied, even in very recent work.

Bakhuisen van den Brink (*loc. cit.* 209) states that *Quararibea funebris* grows also in Brazil, but he cites no specimens with which to authenticate such an extraordinary occurrence. This extension of range is open to very serious doubt.

The type of *Quararibea funebris* is probably not extant. Many of the Llave plants have been lost or de-

stroyed, but a Llave collection of *Quararibea funebris* in the herbarium at Geneva has passed as the type. It is labelled in Llave's handwriting, but the word "typus" has been added in another hand. Although Vischer apparently considered this to be the type, it probably does not represent the collection from which *Lexarza funebris* was described, because Llave explicitly stated that the branch which was sent to him for description bore flowers and fruits; the Llave collection in Geneva is sterile and has no indications of ever having borne flowers or fruits.

Quararibea Fieldii *Millspaugh* in Field Col. Mus. Bot. 1, 1 (1897) 309—Millspaugh in Field Col. Mus. Bot. 1, 1 (1898) 379—Vischer in Bull. Soc. Bot. Genève, s. 2, 11 (1919) 210—Standley in Contrib. U.S. Nat. Herb. 23, 3 (1923) 788—Bakhuisen van den Brink in Bull. Jard. Bot. Buitenzorg, s. 3, 6, 2 (1924) 210—Standley in Field Mus. Nat. Hist. Bot. Ser. 3, 3 (1930) 354—Standley in Field Mus. Nat. Hist. Bot. Ser. 12 (1936) 251.

SPECIMENS EXAMINED:

Specimens referable to Quararibea Fieldii:

Gaumer 879, August 1895, Yucatan (F—TYPE), (F, G, NY, US—ISOTYPES); *Lundell 6507*, June–August 1936, British Honduras (M, US); *F. Morton 359*, December 21, 1928, Guatemala (F); *Schott 18*, November 18, 1864, Yucatan (F); *Schott 18a*, November 18, 1864, Yucatan (F); *Standley 54638*, December 6, 1927–March 20, 1928, Honduras (US); *Steere 1472*, June 22, 1932, Yucatan (F, M); *Stevenson & Smart s.n.*, December 1930, British Honduras (M); *Stevenson & Smart 146*, December 9, 1930, British Honduras (F); *Stolf 59*, British Honduras (F).

Sterile specimens probably or possibly referable to Quararibea Fieldii:

Bartlett 12220, March 21, 1931, Guatemala (F, M, NY, US); *Gaumer 23987*, 1917–1921, Yucatan (F, US); *Gentle 1716*, August 20, 1935, British Honduras (F, M); *Lundell 45*, October 1928, British Honduras (F, M); *Record & Kuylen H66*, February 16, 1927, Honduras (NY, US); *Steere 1605*, June 28, 1932, Yucatan (M); *Williams 8317*

March 1937, Vera Cruz (F, US); *Williams 8500*, March 1937, Vera Cruz (F, M, US).

Specimens filed hitherto in herbaria as (but now excluded from) Quararibea Fieldii:

Standley 53137, December 6, 1927–March 20, 1928, Honduras (A, F, US).

VERNACULAR NAMES:

batidos; canela; coco-mamá; madre de cacao; maha; majahas; xmahas.

Quararibea Fieldii Millspaugh, which is somewhat larger in all its parts than *Q. funebris*, is apparently endemic to Yucatan, British Honduras, and Honduras. Sterile specimens from Vera Cruz and Guatemala, however, are very suggestive of *Quararibea Fieldii*, and this species may extend to these western extremes.

Of the many specimens of *Quararibea Fieldii* which I have been able to examine, only one sterile collection has been excluded from the species. I refer to *Standley 53137* from Honduras, which is certainly not referable to *Quararibea Fieldii*. A field note states that this collection was made from a shrub, whereas *Quararibea Fieldii* is a tree. Furthermore, the leaves of the three specimens of *Standley 53137* which I have seen are extremely narrow, linear-lanceolate and highly lustrous above. The shape and texture of the leaves suggest no species of *Quararibea* with which I am familiar and may represent an undescribed, shrubby species. At least, it is certain that this collection can not be referred to the large, broadly-ovate, dull-leaved *Quararibea Fieldii*.

Quararibea verticillaris (*[Moçiño & Sessé] ex De Candolle*) *Vischer* in Bull. Soc. Bot. Genève, s. 2, 11 (1919) 204; Bakhuisen van den Brink in Bull. Jard. Bot. Buitenzorg, s. 3, 6, 2 (1924) 211.

TYPE: Apparently not extant. Represented by a drawing of a Sessé & Moçiño collection: De Candolle, Calqu. dess. fl. Mex. (1874) t. 99.

Myrodia verticillaris [Moçiño & Sessé] ex De Candolle Prodr. 1 (1824) 477—G. Don, Gard. Dict. 1 (1831) 508—Dietrich, Syn. Pl. 4 (1847) 807.

Although this species has not been collected subsequently in Mexico, and although its provenience in Mexico is unknown, it is nevertheless obviously distinct from *Quararibea funebris* and from *Q. Fieldii.* The drawing which serves as a type indicates clearly several diagnostic points of distinction, but without material for comparison and study it is difficult to determine the exact relationship of this species to the others of Central America. Vischer (*loc. cit.* 204) places *Quararibea verticillaris* in the subgenus *Archiquararibea*, indicating his belief that it is more closely allied to *Q. Fieldii* than to *Q. funebris.*

Quararibea turbinata (*Swartz*) *Poiret* in Lamarck Encycl. Suppl. 4 (1816) 636.

De Candolle reported this species from Mexico as *Myrodia ovata* Moçiño & Sessé in synonymy under *Myrodia turbinata* Swartz. I have been unable to find a collection from Mexico which could be referred to this West Indian species. It is possible that the specimens upon which de Candolle based his report were erroneously identified, for specific distinctions in *Quararibea* have long been confused. Bakhuisen van den Brink (*loc. cit.* 15) has repeated this reported occurrence of *Quararibea turbinata* in Mexico, basing his statement probably on de Candolle's earlier report.

It is doubtful, in my opinion, that *Quararibea turbinata* occurs in Mexico. Therefore, I have not included a complete bibliographic summary of this species.

II. The Use of Quararibea Flowers as a Spice for Chocolate

In Mexico, the dried flowers of *Quararibea funebris*

and *Q. Fieldii* are used as spices for chocolate drinks, to which they impart a pungent, slightly peppery taste.

In the large native market in Oaxaca City, Oaxaca, a number of interesting local plants are offered for sale as medicines, charms, foods, and clothing materials. One of the most striking of these economic plants is *Quaribea funebris.*

The great central plaza of this market has three stalls where drugs are sold. In each of these drug-stalls, the herb-sellers or *herbolarios* offer scores of plant remedies for sale; each stall is plentifully supplied with dried flowers of *Quararibea funebris.* The Zapotecs of the Valley of Oaxaca use a decoction of these flowers as an aromatic cough remedy, but by far the greater part of the supply is utilized to flavor chocolate drinks.

Smaller village markets in the vicinity of Oaxaca City also sell the *flor de cacao,* but I have searched for it in vain in the important markets in Teotitlán del Camino in northeastern Oaxaca and in several markets in the State of Puebla. A small quantity of these flowers was found in an Indian shop in the remote Chinantec village of San Pedro Yolox in the District of Ixtlán, Oaxaca: here, however, the spice was obviously obtained in trade from the Valley of Oaxaca, for *Quararibea funebris* is a tree of the warm, dry desert, not of the cold, damp, forested mountains of the interior. Similarly, *Quararibea funebris* must be received in trade in the town of San Ildefonso Villa Alta in the District of Villa Alta, Oaxaca, where many of the inhabitants spoke to me of its use in chocolate drinks. Nevertheless, I was unable to find it in the prosperous market of this large Zapotec town.

The use of *Quararibea funebris* as a flavoring agent in chocolate drinks is not confined to the Indian population of Oaxaca. The *mestizos* and Spanish inhabitants also enjoy the combination of the aromatic flavor of the flow-

ers with rich chocolate. The flowers are added, ordinarily dried, during the preparation of the beverage, which in Oaxaca is usually some form of *pozonque*. *Pozonque* is made with finely ground corn meal and chocolate and is very nutritious. Occasionally, young shoots of a species of *Dioscorea* are added, and the beverage is beaten vigorously into a thick, albuminous froth. Fruits and other ingredients may sometimes be added.

As well as imparting to the beverage a peppery taste and aromatic odor, the flowers of *Quararibea funebris*, containing large quantities of mucilage, have a tendency to thicken the water in which the corn and cacao particles are suspended.

To his type description of *Quararibea funebris*, Llave[1] appended a long discussion of the habit, occurrence, and economic importance of the tree. A translation (by the writer) of this discussion follows. (Cf. Standley in Contrib. U.S. Nat. Herb. 23 (1926) 788).

While making a military expedition to the southern region between Oaxaca and Angelopolim, Guadalupe Victoria, the President of the Republic, passed through Izucar and admired the funereal majesty of *Lexarza*. He ordered a flowering and fruiting branch sent to me with the instructions that a description of it be made. Later, my beloved colleague, Doctor José Ignatio Luna, a worthy authority of Izucar, sent pictures of the tree and accurate measurements together with the information that the primitive natives were accustomed to come to mourn their dead under the magnificent shelter formed by the low branches of the tree. He stated also that the flowers were mixed with *pozonque* (a drink made from cold chocolate which is used at weddings and fiestas) in order to flavour it. For this reason, perhaps, the tree is popularly called *cacahuaxochitl*, which may be rendered into Spanish as *flor de cacao*. According to this same authority, no other tree of the same species is found in Izucar or in the general vicinity. Doctor Miguel Valentino of Huamantla, an authority on natural history and no mean observer, studied the description of *cacahuaxochitl* and assured me that on his trip through the Mixteca he saw trees of this species.

[1] Llave: in Llave & Lexarza Nov. Veg. Descr. 2 (1825) 8.

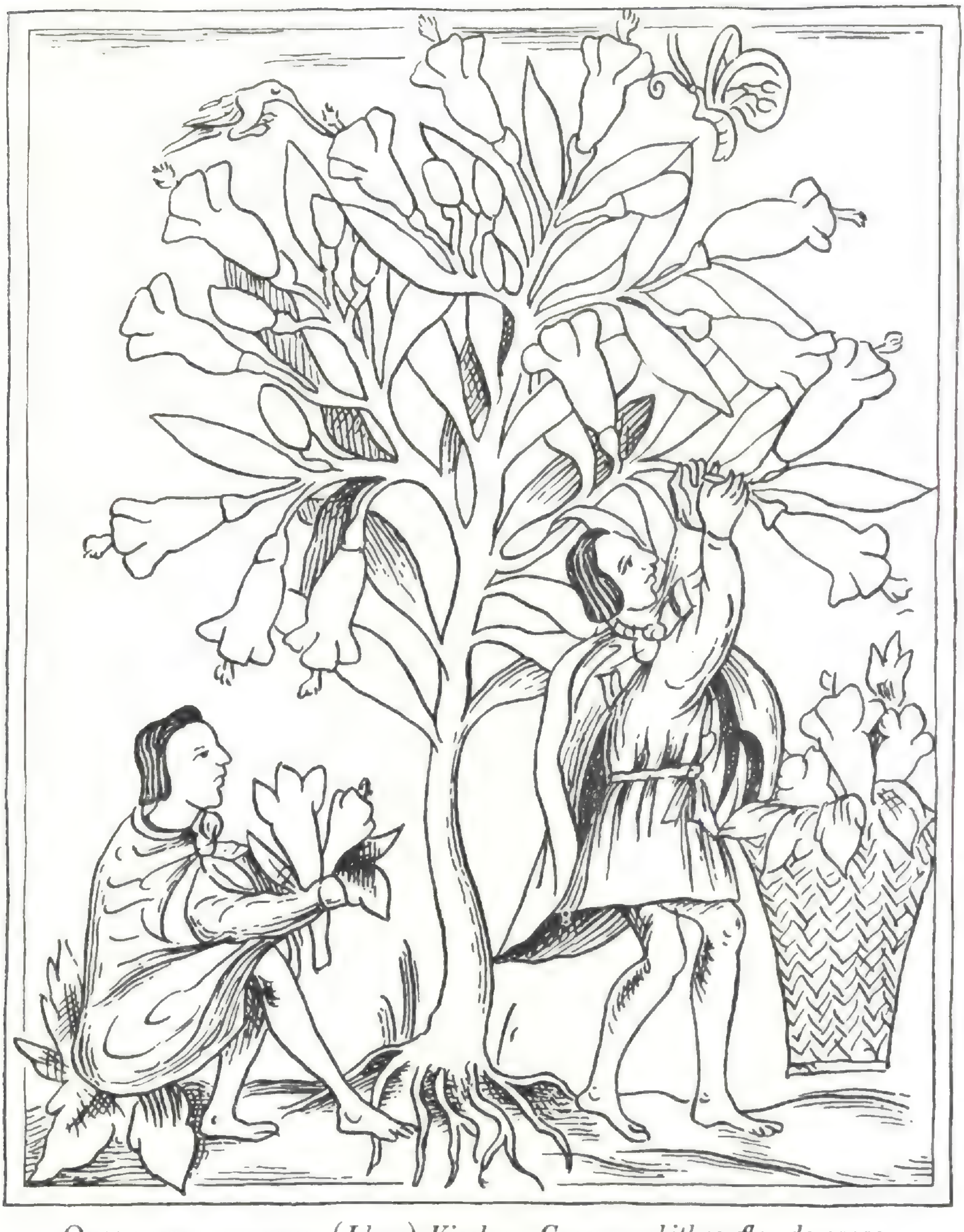
Ximénez (*Cuatro libros de la naturaleza y virtudes medicinales de las plantas y animales de la Nueva España* (1888) xlix, 184) described a flower which was known as the *flor de cacao*. León identified this as the flower of *Lexarza funebris* Llave (*Quararibea funebris*). A consideration of the brief description of the plant, however, indicates that this determination is incorrect. Described under the heading: *De la que llaman cacahuaxochitl o flor de cacao*, the plant to which he referred had cordate leaves, purple flowers, and a strong fragrance; furthermore, it was considered a remedy for intestinal bleeding; and it was hot and dry to the taste. Although Ximénez did not state that it was used to flavor chocolate, this use might possibly be inferred from the name, for a number of flowers, fruits, seeds, and leaves were and are used in Mexico for this purpose, and some of them have the same or similar names. *Quararibea* differs in several important respects from the *cacahuaxochitl* of Ximénez: it has ovate or elliptical (never cordate) leaves: and the flowers are pure white (never purple).

Sahagún (*Historia de las cosas de Nueva España* 3 (1938) 274) also described a plant which was called *cacauaxochitl:*

> There are also other trees called *cacauaxochitl* which bear flowers which are called *cacauaxochitl*. They are like jasmine and have a very delicate but pungent fragrance.

Cacauaxochitl is illustrated in the Paso y Troncoso edition of Sahagún's *Historia de las cosas de Nueva España* (figure 684, lam. cxiv). The illustration, a copy of which is reproduced here, Plate LVIII, represents a tree which is abundantly flowering; two Indians are pictured beneath the tree, gathering the flowers in baskets. Although it is crudely drawn, this plate illustrates without any question the bombacaceous *Quararibea funebris* or *flor de cacao*.

Plate LVIII



Quararibea funebris (*Llave*) *Vischer*. *Cacavaxochitl* or *flor de cacao*, reproduced from the Paso y Troncoso edition of Bernardino de Sahagún: Historia general de las cosas de Nueva España.

References to the use of *Quararibea funebris* as a spice for chocolate amongst the Aztecs are apparently unavailable, although the Sahagún reference might seem indirectly to indicate that the flowers were put to this use. It is indeed singular that reports are lacking for the Aztec region, because the Aztecs, whose nobility is stated to have consumed much chocolate, imported many plants and plant products from southern tributaries. Furthermore, numerous references attest to the fact that the Aztecs were accustomed to flavor chocolate drinks with flowers, seeds, and other plant parts.

Quararibea Fieldii, like *Q. funebris*, is utilized as a spice for chocolate. It is a tree of the Mayan region and has been used by the Mayas from very early times.

In the *Diccionario de Motul* of the 16th Century (Diccionario de Motul, mss., 16th Century. Quoted in Roys: *Ethnobotany of the Maya*, Mid. Am. Research Ser. Publ. 2 (1931) 263), the use of *Quararibea Fieldii* flowers is mentioned. A translation of this early report follows:

Maha: a certain tree with odorous flowers which they throw into chocolate, and the flowers themselves.

The earliest modern report relative to the utilization of *Quararibea Fieldii* as a spice is to be found in the original description of the plant. Millspaugh stated that the "flowers are used to flavor chocolate" (Field Col. Mus. Bot. 1, i (1897) 309).

Other than these few botanical reports and the references from the *Diccionario de Motul*, I have been unable to find published indications concerning the extent of the use of the spice in the Mayan area. Lundell (in Pap. Michigan Acad. Sci., Arts Letters 24 (1939) 56), who has carried on botanical and ethnobotanical work in the Yucatan peninsula and adjacent regions, fails to mention the use of *Quararibea Fieldii* as a spice but notes its use

in other ways in his recent *Plants probably utilized by the Old Empire Maya of Petén and adjacent lowlands.*

It is interesting to note in passing that, because of the verticillate condition of the branching of species of *Quararibea*, the young shoots of these trees are used in many parts of Central America and the West Indies in the manufacture of the frothing-sticks or *molinillos* with which chocolate drinks are beaten. There are reports of this use of *Quararibea* from Mexico (in Contrib. U.S. Nat. Herb, 23, 3 (1926) 787–788), Costa Rica (*Plantas usuales de Costa Rica* (1908) 115), and other places in Middle America. Even in Puerto Rico and the Virgin Islands, *Quararibea turbinata* Poiret is known as the "swizzle-stick tree" (Britton & Wilson: Sci. Surv. Porto Rico & Virgin Islands, 5, 4 (1924) 569). Because of this extensive use, a number of the vernacular names of the trees refer to frothing-sticks: *molinillo*, *batidor*, etc. The name of one species is said (Record, *loc. cit.* 20) to be *cinco-dedos* ("five fingers"), likewise in reference to the interesting verticillate branching.

An examination of other vernacular names of *Quararibea* trees and their flowers should prove of interest. It is indeed significant that the common names are so inextricably associated with cacao. *Quararibea* does not resemble *Theobroma*, although the two genera belong to related families. Nor does *Theobroma* possess the characteristic odor of *Quararibea*. It seems probable, then, that the association has arisen either from the use of *Quararibea* flowers to spice chocolate drinks or from the widespread utilization of *Quararibea* twigs in the manufacture of frothing-sticks for making chocolate drinks.

A few examples will illustrate the extent of the association of *Quararibea* with *Theobroma*, as shown by the vernacular names. In Oaxaca, *Quararibea funebris* is called *cacaoxochitl* (Nahuatl: "cacao-flower"), *flor de*

cacao, *rosa de cacao*, *rosita de cacao*, and *tepecacao* ("wild cacao"). In the Maya area, *Quararibea Fieldii* is known as *coco-mamá* and *madre de cacao*. In Colombia, *Quararibea Cacao* (Triana & Planchon) Baillon is associated with *Theobroma Cacao* not only through its scientific name but also through its vernacular name—*cacao simarrón* ("wild cacao").

In Vera Cruz, according to field notes which accompany two Williams collections, a species of *Quararibea* is called *canela*. This is significant, because it represents the transfer of the Spanish name of the commercial cinnamon (*Cinnamomum zeylanicum* Nees) to *Quararibea*, and arises undoubtedly from the use of *Quararibea funebris* as a spice.

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THE ORDEAL POISONS OF MADAGASCAR AND AFRICA

BY

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INTRODUCTION

THE conception and employment of various ordeals for the determination of guilt or innocence are not restricted to the history of the more primitive present-day cultures, for they were well known to the societies of our European ancestors. The former practice of witch-dunking in England and Colonial America is still remembered as an evolutionary product of medieval witch trials. Under the same general principle falls Medieval Europe's ordeal of the bier, in which a murderer's guilt was said to have been established when his proximity to the victim's body caused its wounds to bleed again.

Although the above customs are physically different from ordeals by plant poisons, they serve as a link between modern cultures and those of the primitive Africans, affording aid in understanding how and why these practices were able to maintain such a powerful influence over the lives and thoughts of the people. Both types of trial were governed by the underlying belief in the presence of a spirit who would distinguish, regardless of circumstances, between the guilty and the innocent.

Ancient Europe's position in relation to this problem is easily sketched. Although occult evil existed in the

form of witchcraft and sorcery, the people held a simple but profound belief in the God of their church, and possessed a strong faith in His ability and promptness to dispel all things contrary to His will.

In direct contrast to this security was the situation of the African jungle-dweller, whose life was ruled by myriad ceremonies, actions, and reactions, all revolving about an equally large number of extra-sensory beings who controlled every facet of his life. Both good and evil, these beings continually required courting or placation in order that the good spirits might make or keep his lot bearable, and that the bad might be prevented from exerting their evil influence. There seems to have been a concept that the good could prevail over the bad, but to accomplish this end, the native had constantly to pit the two factions, as it were, against each other, never allowing the good to be neglected, nor the bad encouraged. Under these circumstances of constant insecurity and tension, it is possible to see how easily the uneducated and superstitious native could adopt the handiest means for discovering the causes of any unfortunate incident.

In several instances, there exist legendary explanations of the beginning of the ordeal. One such is found in the folk-lore of the Kamanga people of the upper Lake Nyassa district. (Young, 1931)

> Long, long ago God told mankind that there were many troubles in the world. He said 'You have chiefs and leaders, freemen and serfs; the fools, the cunning, and those without protectors; *wasanda*. Among you all there are those who are puffed up because of their position; there are deceivers as well as troublers of other sorts?' And God gave us this tree saying, 'If your fellows for any reason do you ill, take this tree as the support of your case; *kujivikirira;* and if the man has truly done evil, he will die.' It was thus that *muavi* came among us.

However, although history and folklore are both relatively silent as to the physical means by which the custom

of ordeals by poison became established and organized in the cultures of the ancient Africans, several hypotheses may be extended as possible explanations.

Assuming that a belief in witchcraft was far older than the natives' knowledge of poisons, it seems possible that, at certain times, the imprecations cast by witch doctors with the purpose of apprehending criminals coincided with deaths resulting from the mishandling of little-known poisons. Over a period of time, a sufficient number of incidents of this sort may have occurred enabling a relationship between the imprecations and the deaths to be noticed. This theory, of course, rests completely upon the possible alacrity of the natives in noticing these events and establishing a directional meaning for them. As tenuous as this may seem, both a faith and a practice in this type of judicial procedure could easily have sprung from the natives' constant search for security among things beyond their comprehension. Concerning the many ramifications of method which evolved, it may only be suggested that experimentation and coincidental success were the dominating factors.

A second hypothesis of development is suggested by the fact that, in view of his complicated religious outlook, the native had no way of knowing in what form or manner some manifestation of witchcraft might strike. It is possible that a group of food-seeking natives mistakenly gathered a heretofore undiscovered poisonous plant instead of one of their standard fare. After ingestion, varying internal factors caused some natives to die and others to live. Circumstances may have led to the feeling that those who died had had some connection, conscious or otherwise, with witchcraft. It is certainly a form of primitive logic to attribute inexplicable occurrences to the influence of supernatural beings. However, such suggestions only illustrate, in some measure, how

the natives may have interpreted certain phenomena, for no means exist by which their worth may be confirmed or rejected.

Once trial by ordeal became established, it experienced an extremely widespread and devoted adoption by a large number of African tribes. Insecurity was undoubtedly a major factor in its success since most of the natives were so awed by the thought of evil spirits that they dared not retaliate for any wrong done to them by a fellow human being. Personal discussion between the offended and the offender was impossible. Fleeing to another village would mean social condemnation and a miserable life. And taking the problem to the head men of the village would result only in the awarding of the case to the defendant who could pay the larger amount. Hence, the native considered the ordeal a valuable means of security, for it afforded definite protection against false accusations and other troublesome situations. It clarified each atmosphere of suspicion and hostility. Moreover, in many tribes there was no personal stigma attached to the loser or his family, since the natives believed that one could be unconsciously controlled by demons.

The applications of the ordeal covered any and all personal and social crimes, but its widest use was in cases of suspected witchcraft. This is understandable when it is remembered how completely life was ruled by extrasensory beings. Every social malady, be it an epidemic, a natural death, bad hunting, or any everyday discomfort, was ascribed to the action of demons. This concept remained abstract in some tribes, notably those of East Africa, but in others it was believed that some member was either consciously or unconsciously responsible for every unfortunate occurrence. It was in this latter type of culture that the ordeal achieved its greatest and most pervading influence. For the only possible way to resist

the efforts of demons was to fight them with a stronger charm, the spirit in the ordeal poison.

The following discussion of the various poisons will be organized according to the locale in which each was used. While there is a certain overlapping between these locations and the geographical distribution of the pertinent plants, this system results in far less confusion than would a classification based either on the families to which the plants belong or on the tribes which used them.

The families which supplied the bulk of the ordeal poisons are the *Loganiaceae*, *Apocynaceae*, *Leguminosae*, and *Solanaceae*. Representatives of the *Leguminosae* and the *Apocynaceae* are found throughout the continent and in Madagascar; the *Solanaceae* are generally distributed in Africa and species of the *Loganiaceae* occur in both East and West Africa. In addition to these, there are a number of families each of which supplied one or more species to the collection of poisonous ordeal plants. Several representatives of this category are the *Combretaceae*, *Sapotaceae*, *Euphorbiaceae*, *Polygalaceae*, and *Asclepiadaceae*.

A classification based on the plants used by individual tribes is not feasible because the majority of early anthropological writings refer only to the local name for a particular poison. This has resulted in an ambiguity of both the nature of the individual poisons and the names which were used in reference to the ordeal in general.

It might also be added that, in many cases, exact information concerning the preparation of the poison and the identity of the particular plant is incomplete, for the native medicine men guarded jealously the secrets of their trade. It was only after much effort on the part of investigators that the small amount now known was discovered.

The methods of employing these poisons in the ordeal

varied considerably from area to area, but the basic procedures for most were similar. A suspect was given some of the poison to eat or drink, depending upon its form; if his stomach rejected it and he vomited, he was usually deemed innocent: conversely, if he retained the poison he was considered guilty, and was either allowed to die from its effects or was disposed of, according to his crime, in a variety of other fashions.

Madagascar

Due to its small size and isolated location, Madagascar is one of the few areas for which there exists a progressive recorded history of ordeals by plant poison.

Native folklore, as would be expected, considered the sorcerers and evil magicians the plague of society. They were responsible for all ills. Flacourt, in the 17th century, was one of the first investigators to write about the natives' methods of apprehending these evil beings. His descriptions, however, are of little value, for he mentions the genus or species of few plants, and seems to have missed the significance of their use in opposition to witchcraft. It remained for Virez to state the essence of the custom in the following excerpt from one of his writings: (Virez, 1822)

> Les Madécasses, comme tous les peuples barbares, croient beaucoup à la sorcellerie: ils s'imaginent qu'on ne peut pas perdre de bestiaux ou essuyer d'autres melheurs sans que des sorciers jaloux en soient cause. De là resulte un grand nombre d'imputations contre des individus dont on se croit victime, et de violents querelles pour lesquelles on invoque l'autorité des arbitres ou des juges.

Thus, the action of poisons, which were incomprehensible to the people, came to be employed in the judging of equally inexplicable problems, the constantly recurring unfortunate incidents of life.

The use of these poisons continued without interrup-

tion until the early part of the 19th century, when some of the more civilized leaders of the people became horrified at the spectacle of the mass ordeals. An early attempt at regulating was made in 1828, but the first sign of response came in the 1840's when dogs or chickens were occasionally substituted for human participants. This substitution, however, was employed only in the judging of minor offenses, with the loser falling subject to a fine. Direct usage of humans was still practiced in the greater crimes, the most serious of which was suspicion of witchcraft.

The situation continued as such until 1865, when the practice of ordeal by poison was officially condemned and prohibited throughout the island. The immediate effect of this edict was to curtail the practice in the environs of large population centers which had adequate governmental supervision. Outside these areas, however, the practice continued to flourish, and began to lose popularity only in the latter years of the 19th century, when the combined efforts of officials and missionaries effectively reduced its incidence. Several occurrences in 1911 showed that it still had a small, clandestine following, but the practice is believed to have been entirely effaced by 1920.

Tanghinia venenifera Poir

The most common and widely used poison was the so-called "Tanghin of Madagascar." This plant is a member of the *Apocynaceae;* it has been known by various generic and specific names. Among these are *Cerbera venenifera* Steud. and *Cerbera Tanghin* Hook. It was known in the vernacular as *tangin, tangena,* the tangena nut, and *manréchetsé.*

According to Lasnet and Boyé (1911), the plant is a large tree, ten to twelve meters high, which grows mainly

in the forests of the eastern coast. All parts contain poison to a greater or lesser degree, but the nuts or kernels are most toxic. This toxicity results from the presence of a cardiac glycoside, tanghinin ($C_{27}H_{40}O_8$), whose physiological properties resemble those of strophanthin and ouabain. Its action produces dyspnea, restlessness, and vomiting, followed by slackening of the heartbeat and the abolition of voluntary movements. Convulsions and exaggeration of the reflexes precede death, which is caused by the halting of respiration.

Tanghin was employed in the judgement of all crimes, including those of conspiracy, poisoning, and stealing, but its main use was in the apprehending of those believed to be in league with, or controlled by, sorcery. Since there existed, as in many societies, a group of people upon whom suspicion was most likely to fall, constant persecution and subjection to the poison were common. However, during times of stress, this situation was magnified so that all groups in a community were viewed as possible contributors to evil, and, hence, as candidates for the ordeal.

For example, a series of epidemics and evil occurrences in the year 1830 spurred the sovereign into issuing a resolution to "purge the country and kill the rats," meaning to rid it of its sorcerers. Tanghin was the judge; no class was exempt. The slightest suspicion was a valid indictment. Trials of this sort, with the highest and lowest submitting together, resulted occasionally in the annihilation of 6000 people at a time.

After a while, the frequency of these massacres abated, and the ordeal came to be applied almost exclusively to the lower classes. Although the medicine men were often corruptible, the poverty of these groups rendered this a small factor to all but the occasional wealthy person who was called to participate.

This corruption was possible because the medicine men had methods of varying the strength of the poison according to the size of the bribe, or to their own judgements of the person's guilt or innocence. Thus, in a dispute between two parties, both were served poison, but the toxicity of one dose was often altered by the decision of the administrator. Slaves who were not royal property were usually given non-toxic doses. Then, when they had partially succumbed, they were removed, revived, and carried to distant villages where they were sold. However, royal slaves were customarily forced to endure the entire ordeal, and usually died.

In conjunction with the widespread corruption of witch doctors was the fact that cruelty in dealing with the accused persons was ever present. In 1831, an officer suspected of sorcery was "keeping the watch" by his father's body when his captors arrived. In spite of his pleas that his action was an innocent custom, he was carried off to the ordeal. In another case, a man who was unable to rise because of a fever was taken on his bed to the place of administration where his dose was doubled "to clear up the fever." So strict was this lack of mercy, that few friends or relatives of the accused ever dared dispute the summons lest they be forced to submit on suspicion of complicity. (Chatin, 1873)

However, in spite of these corrupt practices, the people usually had an unswerving faith in the ordeal's inherent justice, and drank the poison with willingness and assurance. They believed that there was a good spirit present who would strike the hearts of the guilty, and pass by those of the innocent.

Aside from the earlier practice of executing criminals by pricking them with a lance dipped in the juice of the kernel, the normal method of administration was as follows: While present before the judge(s), the person was

given an amount of rice soup or rice water to drink. When this had been done, he was given three pieces of chicken skin to swallow without chewing, each piece approximately the size of a silver dollar. Then he was fed the tanghin, which had been mashed and mixed with the juice of bananas and either the leaves or the juice of cardamons. Since the poison acted rapidly, one of the judges would immediately place his hands on the head of the accused and utter these or similar incantations to the genie of the nut: (Perrot and Vogt, 1913)

> Listen! Listen! Listen!
> And be attentive,
> Rainimanamango?
> You are a round egg
> Which God has made perfectly.
> Although you do not have ears, listen!
> Although you have no mouth, respond!
> Listen! Listen! Listen!
> And be attentive
> O Rainimanamango!''

The prayer continues, but it is largely repetitive, requesting that if the accused is innocent, he should vomit the three pieces of chicken skin. There are also imprecations which were to apply if he were guilty. During or after the prayer, the accused usually vomited. If this were delayed, he was fed more rice water or soup. When he did vomit, the egested material was examined closely for the three pieces of skin, the evidence of his innocence. If all three were not found, or if the subject's stomach failed to reject the mixture, he was immediately pronounced guilty. Often the person who was thus deemed guilty died before the end of the test. But more often, the poison was not allowed to complete its work. Instead, as soon as these condemning effects became established, the people fell on the convicted one and shortly dispatched him. The relatives of the person executed in

this manner were often compelled to undergo a public washing to cleanse themselves of all possible implication before they were again accepted by the village.

The natives' explanation of sorcery clarifies the need for locating all three pieces of skin. It was their belief that certain evil spirits caused all human ills. These spirits, however, invariably assumed a human form. Thus, any member of the society might even from birth have been dominated by one of these beings. So firmly entrenched was this belief, that a husband might unquestioningly turn upon his wife, if her guilt were established by ordeal, and mutilate her along with the crowd. The peculiar significance of the skin was contained in the fact that these spirits were thought to survive on the flesh of their human victims. The retention of the symbolic chicken skin, therefore, signified the nature of that person's food, while the expulsion of the flesh naturally exonerated him from all suspicion.

In different regions of the island, various modifications of the basic procedure were introduced. In certain cases, the accused merely swallowed two pieces of the kernel wrapped in skin. Then without the rest of the standard ceremony, i.e., rice soup, etc., the effects were awaited. Another modification involved the pulverizing of the kernels on a rock. This debris was then made into an infusion with water and was fed to the accused. At times, the quantity of rice water or soup was strictly limited, a practice which resulted in increasing the toxicity of the poison. Finally, one of the most ancient methods consisted in attaching the victim to two poles in the ground, and presenting him with two cups of the expressed juice. The accused had to drink these rapidly, and usually died quickly. As in later practices, those who vomited were declared innocent. This latter method indicates the contrast between the early trials and the

highly ceremonious procedures which later evolved.

It was known among the people that the quantities of rice water and spices might radically alter or strengthen the toxicity of the poison. Thus, they believed that a strict adherence to the ceremonies of gathering and preparation had to be maintained lest the slightest error cause the death of an innocent or the salvation of a guilty person. This belief gave the witch doctors full power to direct each ordeal as they desired, for they maintained that they were the only members of the society sufficiently versed in the correct procedures to perform the various ceremonies without making errors which could lead to a miscarriage of justice. An interesting point, however, is that the people realized the existence of this control. Their tolerance can be explained only by supposing that they believed it possible for the genie of the plant partially to work through these men.

Chatin (1873) summarized the physical factors which could control the outcome of the trial. The items illustrate the necessity for the strict laws governing the ceremonies.

The controlling factors were:

1. An ignorance of the true fruit.
2. The inherent ability of the fruit to kill or to save.
3. The victim's possession of a charm to protect him.
4. The presence at the trial of a person with a similar talisman.
5. The presence of an evil genie who could grasp the person and destroy him.
6. The impure state of the person who would have committed some wrong.
7. The varying maturity of different fruits.

The last factor was the only one controlled by the people, for it was known that the red color deepened with

maturity, and that maturity brought an increase in the toxicity of the poison. A dark-red fruit indicated almost inevitable death. To accomodate this factor, the victim's relatives had the right to request the replacement of the dark fruit with a lighter one.

There is little written about the effects of the poison, for the accused was usually attacked and killed when he showed signs of succumbing. It is thought, however, that soon after ingestion, nausea appeared and was followed by a partial paralysis which soon developed into an exaggeration of the reflexes. Convulsions, weakness, and a halting of the heart and respiration then brought a swift death.

Menabea venenata Baill.

Similar in usage, but overshadowed by its powerful ally, was ***Ksopo***, *Menabea venenata* Baill. of the *Asclepiadaceae*. This plant grows exclusively in the arid regions of the west and northwest parts of the island, where it was used as an ordeal poison by the Sakalave tribe. According to the area, it was known by the additional vernacular names *kissoumpo*, *kisoumpa*, *psokoy*, *tanghin de menabé*, *tanghin femelle*, and rarely, *kimanga*.

The chemical nature of this plant's active principle has not been conclusively determined, but it is known to be a powerful cardiac glycoside.

The poison was administered by having the accused chew the plant's root or drink a decoction of it in water.

Its physiological effects were rapid. Soon after ingestion, the victim experienced violent and persistent vomiting. During this time, the participant gradually lost consciousness. The heart would accelerate wildly several times, but would then slow down and remain passively irregular. At about this point, slight convulsions and contractions of the muscles of the anterior members

began. A failure of coordination over the whole body preceded violent trembling. Then the convulsions disappeared and paralysis took place. Just before death, groups of heartbeats paralleled the respiratory rhythm. As death approached, this rhythm changed, and a final convulsion wracked the body as the heart stopped beating, approximately one-half hour after ingestion. (Perrot and Vogt, 1913)

Although Perrot has written twice of this plant, at neither time does he mention the ceremonies and conditions of the ordeal. What indicated innocence? And what were the signs of guilt? In answer to these questions, it may only be assumed that the above account was the experience of a guilty person, for no significance was attached to vomiting, the usual criterion of innocence. Furthermore, it must be assumed, from the evidence at hand, that death was the differentiating factor. This indicates a highly toxic active principle, for among the majority of plants used in the ordeal, the act of vomiting was sufficient to save the participant's life.

Erythrophleum Couminga Baill.

The third and last of the known Madagascar ordeal poisons came from *Erythrophleum Couminga* Baill., a member of the *Leguminosae*. This great tree was known by the vernacular names *komanga*, *kiminga*, *kimanga*, *koumanga*, *koumango*, and *kimango* in addition to the most common appellation, *couminga*. Its highly toxic bark was used as an accessory poison in ordeal trials throughout Madagascar and the Seychelles. In certain areas, however, it was regarded even above *tanghin*.

So greatly did its toxicity impress the natives, that they attributed great power to all parts of the tree. The mere odor of its blossoms, the rain water that washed its leaves, and the smoke from burning parts of the plant

were all supposed to be fatal. Native folklore abounds with tales of people and cattle dying from the slightest contact with any of these elements. However, it is difficult to surmise how these stories became established, for scientific investigation has disclosed that, although the active principles erythrophlein and coumingine ($C_{29}H_{47}NO_6$) are present in varying concentrations throughout the plant, it is hardly likely that death would result from any action other than that of ingesting the bark.

These active principles are extremely powerful in their normal concentration, and join the glycosides strophanthin and ouabain in having the effect of digitalis poisoning. Upon ingestion of a decoction of the root or stem bark, the victim experienced purging and/or vomiting. The heartbeat slowed, then quickened. Respiration became labored. Finally, as the individual was losing consciousness, the heart and respiration stopped simultaneously.

Africa

The ordeal poisons of the African continent were far more abundant than those of Madagascar, yet the great majority of trials by ordeal occurred in the area between the 20th northern and the 20th southern parallels.

The toxic plants from which these poisons were obtained are common and well-distributed throughout this area, although their individual use as ordeal poisons was often restricted to certain locations.

Since the abundance of poisonous plants and the many possible means of employing them were continually in the natives' minds, security from poisoning was unknown. Consequently, a number of insurance measures cropped up. Among the more interesting and common of these was the custom of a host, when entertaining a guest, to sample all the food placed before that person,

thus ascertaining that none of it had been poisoned.

There were a limited number of poisons which were used throughout Africa either as parts of a mixture or as accessory instruments when the standard was unavailable. The white flowers of the atropine-containing *Datura* species of the family *Solanaceae* were one of the most common poisons. Another was the cassava, *Manihot esculenta* Crantz, of the *Euphorbiaceae*. The juice of this plant is highly toxic due to the presence of its active principles, hydrocyanic acid and manihotoxine. Several other plants of this general type were used occasionally, but the above two seem to have been the most common.

East Africa

There existed a distinct difference between the use of the ordeal in East Africa and its employment in the rest of Africa and Madagascar. There was usually less solemnity and depth associated with the trial. In many tribes, the medicine man was either put to death or severely punished if one of the participants died. Because of this lighter approach, strict adherence to certain ceremonies of gathering, preparing and administering the poison was relatively rare. Consequently, the mixture fed to the accused often consisted of many toxic substances which varied according to the administrator and the individual. Frequently, this mixture contained no poisonous ingredients, but was made, instead, from numerous and repugnant organic materials. In this type of ordeal, guilt was established by a lack of revulsion indicated by the participant.

With this lack of specialization came the rise of different uses for the poison. It is significant in the following examples that, although unrelated to the detection of criminals or witches, the poison still performed a function of honor between the world of man and the world of good spirits.

The rituals of ear-boring and the flour ball, both of which were used to decide upon a site for a village, illustrate this. In the first rite, a small boy was seated at the proposed site. A medicine man then pierced his ear lobe with a poison-smeared needle. If the piercing proceded easily, the site was supposedly approved by the spirits. If not, the people were supposed to search further. In the rite of the flour ball, water, flour, and poison were rolled together. If the mixture adhered, the site was approved. When it flaked, however, ancestral consent was lacking and another area was sought. (Young, 1931)

The general term, *muavi*, was used throughout East Africa as an appellation for all ordeal poisons. This must not be confused with *moavi*, for the latter specifically designated *Erythrophleum guineense* G. Don.

Parkia Bussei Harms

The most important *muavi* poison was obtained by the East Africans from *Parkia Bussei* Harms of the *Leguminosae*.

This tall tree, which grows in height from 20 to 26 meters, has an extremely poisonous bark which was used especially by the tribes inhabiting the Lake Nyassa district. It was normally employed in the non-fatal manner characteristic of its locale.

In certain cases, however, as will be mentioned later, death was not excluded from the proceedings. Among the Kaonde people, the poison was given internally, mixed with beer. Vomiting and death were the criteria for guilt or innocence. The person undergoing the trial had to sit on a scaffold in such a manner that no part of his body touched the ground. Anyone might administer the poison. If he vomited, his relatives fought with the person who administered the poison. If he died, his relatives ran away with the corpse, burned it, ground the

bones, and put some of the powder on their faces. The rest was used as a powerful poison. The sorcerer's children were put into slavery.

Detailed information concerning this plant's active principle is lacking, although it is known to have been highly toxic.

The preparation of the poison was as simple as its application. Without the aid of a witch doctor or other official, the disputing parties went to the nearest tree and stripped off some of its bark. This was dried and ground to a fine powder, which was then stored until the time of the trial.

Administration normally took place by proxy, the poison being given to a fowl, dog, or serf, who represented the accused. In a civil case involving two persons, a proxy for each was tried. If one proxy showed adverse effects while the other did not, the case was decided against that party.

The usual treatment of humans was similar. If one retained the poison (which was mixed to be non-fatal) while the other rejected it by vomiting, the first was declared culpable, and paid damages according to his crime. Such were the methods of the normal trial by ordeal in East Africa.

However, there were tribes, particularly in the western Lake Nyassa district, among whom death was an integral part of the procedure. It is interesting to note that with this renewed stress an increased corruption of witch doctors appeared, relating the method to the more brutal ordeals of Madagascar and the rest of Africa.

In these tribes, the two disputants in a civil case took their grievances to a witch doctor. He then assigned a piece of *muavi* bark to each, raised these in the air, and let them fall to the ground. The one whose bark turned in falling was the offender, and his poison would be sub-

stantially stronger at its administration the next day.

Partiality in procedure is further illustrated by the method of dealing with cases in which no individual had been directly accused, a situation which usually arose from suspicion of witchcraft throughout a village. The people stood in a ring while a witch detective walked about, feeling the hands of each. Dressed in the full ceremonial regalia of his calling, this person chanted incantations and mystic imprecations until, after touching the hands of one person, he would jump back in horror and scream condemnations denouncing that person as the offender. If the tribe's affliction had been ascribed to sorcery, the medicine man would then go to a spot in the village, mutter several spells while standing there, and dig up the person's horns (which had been previously buried by the chief witch doctor). Since this piece of evidence was considered incontrovertible proof of guilt, an ordeal was scheduled immediately.

Detection in this manner was sometimes unnecessary, for it was often felt that a particular person, because of his actions or past record, was a likely suspect. This individual would usually be informed of this suspicion and would publicly request the ordeal to vindicate himself. In his situation, there was a chance of survival. But if he had been singled out by the witch detective in the ceremony of the hands, a liaison between the detective and the poison mixer resulted in an especially heavy dose of poison. This procedure was inevitable, for if the person lived it would have implied that the witch doctor had been mistaken. (Duff, 1906)

The poison's administration took place at the chief's hut or the center of the village, and was directed by the head man or, in civil cases, by an intermediate whom both parties had agreed upon. The poison was swallowed raw and rinsed down with water from a small bowl. The

following account by Young (1931) is a typical example of procedure in a civil case.

Before drinking, the accused said:

> If I am guilty of the charge made against me (here reciting the details of the case), then may you reject the medicine; *iwe wa!* And I may retain it; *ine pa!*

This party then drank.

The accuser then said:

> If I have accused you falsely
> of (the details of the charge),
> then may you reject the medicine;
> *iwe wa!* and I retain it; *ine pa!*

Then he drank.

While waiting for the poison to take effect, the village would form sides and, amid the shuffling of feet, shouting, and dancing, each group would chant a song whose words expressed the hope that the other, and not their man, would be taken by the poison.

If both vomited (*iwe wa*), the case was dissolved, for there had been no grounds for dispute. If both died (*ine pa*), both had been lying. But if one died, the other was congratulated for his survival and praised for his virtue either in being innocent or in his truthful accusation of a wrongdoer.

When a person of the lower class died in this manner, his body was thrown to the hyenas, and all felt that they were free from a malign influence. But if a wealthy person succumbed, his relatives either paid heavy damages to the accuser or to the village, or, if they were unable to meet the assessment, sold themselves into servitude, usually to the winner.

At times it became necessary for a group of tribes to ferret out a troublemaker. In this situation, a representative from each village was sent to a central meeting place

to take *muavi* with his coordinates from the other villages. If a particular man vomited, he vindicated both himself and his village from suspicion. But if he retained the poison, it meant that either he or someone in his village was the guilty party. A local ordeal then located the troublemaker.

Acokanthera venenata G. Don

One of the less important *muavi* plants was *Acokanthera venenata* G. Don of the *Apocynaceae*. This plant contains several active principles, the most toxic of which is a crystalline cardiac glycoside called ouabain (or acocantherin). In addition to this principle there are amorphous ouabain (also known as acocanthin, abyssinin, or G-strophanthin) and a third active ingredient, oxalic acid.

This plant, whose active principles occur in all parts, produced death by heart failure several minutes after the ingestion of a concentrated decoction.

The major principle, ouabain, is a crystallized strophanthin ($C_{29}H_{44}O_{12}\cdot 8H_2O$) with about twice the toxicity of normal strophanthin. Its action on the heart and respiratory tract is similar to the effects of digitalis poisoning. Amorphous ouabain ($C_{32}H_{50}O_{12}$) has much the same effect.

Oxalic acid ($C_2H_2O_4$) acts merely as an irritant in small doses and as a corrosive agent in larger amounts, having but a remote inhibitory action on the respiratory and cardiac centers. However, it is still toxic even after dilution has inhibited its corrosive and irritative effects.

Significant to their function in the ordeal is the fact that both ouabain and strophanthin are absorbed irregularly by the digestive tract. There is no means of predicting the amount that an individual will absorb at a given time. Consequently, a dose which was non-fatal to a person on one day might later cause his death. Under such

circumstances, the ordeal's judgement could hardly have failed to gain credence.

The native usage, which consisted of making a decoction in water from the different parts of the plant, produced primarily extreme nausea. This was soon followed by retching and violent vomiting, heavy purging, and complete exhaustion. Immediately before death, several small convulsions signified the halting of the heart and respiration. Upon *post mortem* examination, there was found considerable congestion at the bases of both lungs, a fatty degeneration of the heart muscle, and severe gastro-intestinal inflammation.

Other Ordeal Poisons

There were several other toxic plants often used as ordeal poisons by the natives of East Africa. But because of their small importance, little or nothing has been written concerning their gathering, methods of employment, or physiological effects.

The first of these is *Strychnos spinosa* Lam. of the *Loganiaceae*, the active principle of which is the alkaloid strychnine. This principle acts on the central nervous system producing a halting of respiration immediately followed by heart failure. This plant was employed primarily in Mozambique, where the natives made a decoction in water from the bark.

The second is *Strophanthus Courmonti* Sacl. of the *Apocynaceae*. The active principle in this plant, the cardiac glycoside strophanthin, was obtained from the grains. Its action in small doses is similar to digitalis poisoning, the difference in effects being primarily quantitive rather than qualitative. Large doses cause general tetanus, and leave the heart muscle in a state of contraction resembling *rigor mortis*. (Potter, 1913)

The strophanthin in this plant exists both in the form

$C_{30}H_{44}O_9$ (cymarin), and in the form $C_{36}H_{54}O_{14}$ (K-strophanthin *beta*).

The last ordeal poison of this area is *Erythrophleum africana* G. Don. of the *Leguminosae* (also known as *Gleditschia africana* Welw.). Its active principle, the cardiac glycoside erythrophlein, was extracted from the bark of the roots or stems. The observed physiological effects were similar to those of *E. Couminga*, there being but slight modifications due to differences in concentration.

The methods of employing these minor plants and their poisons in the ordeal probably varied little from the normal procedures of East Africa. However, since descriptions of its use occasionally trace the symptoms of poisoning through to death, it is fairly certain that they experienced some use among the more serious tribes of the western Lake Nyassa district where death was often included in the ordeal.

Central and West Africa

It is in these areas that the ordeal poisons achieved a noteworthy diversification both of plant sources and methods of employment. It is also here that the ordeal reached a frequency and a depth of solemnity far greater than in the eastern and southern regions. Why this situation should have existed is a mystery, for all Africa abounds in poisonous plants of every description. Postulations concerning the natives' temperament are haphazard and almost impossible to substantiate. It may only be suggested that an unusual degree of superstition probably combined with the deep-seated belief that death was a violence against nature. The ordeal then may have risen to great prominence as the detector of the cause of these violences.

Central Africa

Strychnos Icaja Baill.

Strychnos Icaja Baill. of the *Loganiaceae* is the principal source of ordeal poisons in central Africa. Many different names have been applied to this species, but they are all synonyms or represent varieties, as in the case of *S. Dewevrei* Gilg. and *S. densiflora* Baill. There also are numerous vernacular names. This plant has been known in various areas as *bengue*, *benge*, *m'boundou*, *boundou*, *casa*, *caja*, *icaja*, *acaja*, *encaja*, *kassa*, *n'casa*, and *n'kassa*. Unfortunately, these names also implied the ordeal in general.

This tree grows in Gabon, the Moyenne Congo, the Cameroons, and the Belgian Congo. Its active principle, the alkaloid strychnine, is located exclusively in the suberous cellules in the bark of both the roots and the trunk. This principle is a poison of the central nervous system, inactivating first the respiratory centers and then the heart. It was thought, at one time, to possess several different alkaloids because of an observed duality of effects, the one convulsant, the other paralytic. However, experimentation has revealed that this duality results from different doses, and analysis of the bodies of animals experimentally poisoned has disclosed but one alkaloid. An extremely weak dose acts merely as an intoxicant and diuretic.

The progressive fatal effects of poisoning are as follows: Initially there is restlessness, nervousness, abrupt movements, and stiffness of the facial muscles. Then more pronounced twitchings become evident and soon develop into muscular spasms followed by spinal convulsions. In these muscular spasms, which involve all voluntary muscles, the stronger (usually the extensor) of a pair predominates. During this stage the mind is clear.

Each convulsion usually lasts about one minute, and is punctuated by a relaxed condition of depression nearing paralysis. After this 10–15 minute interperiod of relaxation, almost any stimulus will induce the next spasm. If the person does not die during the convulsions, he gradually becomes weaker and the paralysis more prominent. Death ultimately comes from tetanic exhaustion or asphyxiation.

In contrast to several other ordeal poisons, a repetition of administration led not to immunity but to increased susceptibility. (Underhill, 1924)

Methods of employment varied from area to area, but there seems to have been a definite division between Gabon and its environs and the Belgian Congo.

In Gabon, the tree was considered sacred, for the natives, knowing little of cultivation, had not seen fruits drop to the ground, but had noticed young shoots sprouting. They believed that this occurred spontaneously. This sacredness was patronized by the natives, who gathered the bark only in the daytime. For it was believed that, at night, the spirit of the plant was out watching for sorcerers and criminals. A further derivative of this belief is found in the natives' practice of using the poison only on free men. The unworthy slaves were either skinned alive or sold to cannibals.

In this area, the mahogany-red root-bark of young plants was usually used in the ordeals.

These roots were customarily gathered by medicine men who went alone to the woods. The plant was pulled up, the roots cut off, and the bark detached. This was grated into water and allowed to steep. Fermentation quickly took place, and after the effervescence had subsided, the water turned red and the poison was ready. In another method, the macerated bark was placed in water to soak for a day before use.

Although mass ordeals similar to those decreed by the kings in Madagascar did occur, this procedure was distinctly the exception. The poison was given specifically to those who were suspected of having committed a crime or of being in league with sorcerers.

The inhabitants of this area had great faith in the ordeal and willingly submitted to it to clear themselves of any guilt. In connection with this, witch doctors often strengthened or secured their positions by taking the poison publicly. However, they were extremely careful to mix weak doses.

A standard procedure of administration among the Gallois and the Inenga tribes was as follows:

The medicine man drew a line in the ground or designated a tree about ten feet in front of the accused, to whom he gave the drink. As the poison took effect, the medicine man signaled to the accused, who started to walk towards the line or the tree. If he made his goal before collapsing, he was declared innocent, and the people fell upon his accuser, either killing him or forcing him to undergo the same ordeal. If the accused failed to reach the line, however, the people fell upon him and cut him to pieces. (Perrot and Vogt, 1913)

Among the Pahouins, a slightly different procedure is recorded (Lasnet and Boyé, 1911). In the public square of the village, the drink was given to the accused who had to down it in one gulp. When the poison began to act, the medicine man held a stick about 50 centimeters above the ground and indicated that the accused should jump over it. If this were accomplished, he was pronounced innocent and was given his liberty. If he were not able to do it, he was immediately killed or sold to cannibals.

In rare cases, a person who had not been immediately murdered might slowly have started to recover. When this exceptional event occurred, that person was declared

divine, and was looked upon as such for the rest of his life.

In the above tribes, when the person showed his innocence or began to regain vitality, he was given an antidote to rid his stomach of the poison. This antidote was usually palm oil or a repugnant organic mixture. This naturally suggests that some might have tried to fortify themselves against the poison ahead of time. But this rarely happened, for the medicine men had succeded well in maintaining the people's faith in the judgement of the ordeal spirit.

Turning now to the Congo, it is found that there was a basic difference in the preparation of the drink, and several differences in custom and in the interpretation of effects.

In a civil case, in one tribe, each party sent out a proxy to gather the poison bark from a mature tree trunk (called *n'kassa*), rather than from the roots of a shoot (called *m'boundou*). The bark of the trunk was non-fatal, while that of the roots usually caused death. These men would cut a block about 20 by 30 centimeters from the bark, grate it to powder on a stone, and return to the village with this powder and with some intact bark to demonstrate their knowledge of the correct tree. The medicine men openly mixed the powder with water to show that no foul play was involved, and the two participants drank the resulting concoction. This had to take place before ten o'clock in the morning if it were to be successful. If a participant vomited, he was declared innocent. But, if the poison acted as a purge, he was judged guilty and was forced to submit to a prescribed punishment. (Perrot and Vogt, 1913)

The Boloki tribe based their judgement of guilt or innocence on the degree of inhibition of physical ability. Two medicine men simultaneously fed about one tablespoon of the bark to each defendant in a civil case. After

chewing vigorously, the two would then wash the mixture down with sugar-cane wine. After the symptoms of intoxication appeared, the first to fall down lost his case. In the event that both remained standing for an inordinate period, the medicine man would take further charge of the ordeal. He would usually flourish a plantain leaf or stalk in front of the disputants, and order them alternately to jump over it a number of times. During this stage, either one or both of the parties would falter. Finally, one would fall, and the case would be settled. The loser was escorted or carried to his hut, while the winner received the congratulations of the crowd, and was smeared with red camwood powder as a testimony to all that his case had been successful. (Weeks 1913)

Among the Bakongo tribes of the Lower Congo, there existed an interesting antithesis to this interpretation of effects. The accused persons drank the poison at sunrise and prepared to spend the day in the open under the taunts of their tribe. If the poison acted as a purge before sunset, that person was declared innocent. If it did not, he was guilty, and had to pay the usual forfeit decreed by the medicine men. Since the bark of the tree was less toxic than the root bark of the young shoot, death did not usually result. In serious situations, however, *m'boundou* was added, and the relatives of the deceased had to assume the forfeit. Suspicion of witch-craft or murder were the usual crimes for which this custom was observed.

In the M'Boschi tribe, a different procedure was followed. A ring was cleared in the jungle away from the village. Three large trees were then felled across it. The accused was given a strong dose of the poison (about one-third of a liter), which was usually tinted a brighter red by the addition of sandalwood, and had a larger amount

of *m'boundou* in it. When the poison took effect, he had to jump successfully the three trees. If he were able to clear all three, he was innocent. But if he stumbled or fell over any one of them, he was allowed to lie there and die.

Among the Boubanguis, the accused was isolated for three days before the trial. He was then bound and covered with wood to prevent his slightest movement. On the day of the ordeal, a refusal to drink the poison established his guilt, and he was decapitated. If he accepted the drink, he was left bound all day. The medicine men returned that night. If he were still alive, he was judged innocent. In this tribe, the medicine men always prepared the poison secretly. (Lasnet and Boyé, 1911)

In both of the above cases, a heavy emission of urine during the ordeal was usually a sign of recovery and, hence, innocence. Also, in the trials of sorcerers, the people believed that an examination of the dead person's entrails would yield a number of small white pellets which represented the heads of the people killed by the spells he had cast.

Infrequently, in the Congo, the medicine men resorted to the eastern African practice of making a mixture of repugnant materials to test the good faith of the accused in minor cases. However, their interpretation differed from that of the East in that distaste or retching by the accused denoted guilt. This trial was resorted to only when *m'boundou* or *n'kassa* were not available.

In contrast to the rest of Central Africa, there was found among the Azande people of the Northern Congo-French Equatorial Africa region a lessening in severity of human ordeals reminiscent of East Africa. They referred to the ordeal as "consulting the poison oracle," who supposedly lived in *benge*. In these consultations, the question was decided by the action of the poison on

a proxy, usually a fowl. A question was posed in specialized phrasing to the oracle, after which the poison was forced down the throat of the proxy, The answer was interpreted from the extent of the poison's action, i.e., whether the chicken died or lived, and if it lived, what its actions were.

This oracle was of supreme importance in the everyday lives of the people. Its wisdom was sought before every decision of moderate importance. Hence, every man kept his store of poison and chickens, for without them he was lost. It was his only means of protecting himself from all evil, including witches and future bad luck. Other tribes had numerous non-poisonous oracles to help them in their lives, but the Azande placed complete faith in his poison oracle.

The frequency of consultation varied individually, but the following is a basic list of situations about which the oracle was most often consulted : (Evans-Pritchard, 1937)

To discover why a wife has not conceived.
During pregnancy of wife, about place of delivery, about her safety in childbirth, and about the safety of her child.
Before circumcision of a son.
Before marriage of daughter.
Before sending son to act as page at court.
In sickness of any member of family. Will he die? Who is the witch responsible? etc.
To discover the agent responsible for any misfortune.
At death of kinsman in the old days. Who killed him? Who will execute the witch? etc.
Before exacting vengeance by magic. Who will keep the taboos? Who will make the magic? etc.
In cases of sorcery.
In cases of adultery.
Before gathering oracle poison.
Before making blood-brotherhood.
Before long journeys.
A man before marrying a wife.
Before presenting a prince with beer.
Before large-scale hunting.
A commoner in choosing a homestead site.

Before accepting, or allowing a dependant to accept, European employment.
Before becoming a witch-doctor.
Before joining a closed association.
A man before he and his adult sons go to war.
In cases of disloyalty to a prince.
A prince before making war.
To determine disposition of warriors, place and time of attack, and all other matters pertaining to warfare.
A prince before appointing governors, deputies, or any other officials.
A prince before moving his court.
A prince to discover whether a communal ceremony will terminate drought.
A prince to determine the actions of the British District Commissioner.
A prince before accepting presents and tribute.

Among the Azande, humans drank the poison only as a result of three situations. A man who was accused of a serious offense might offer to drink the poison if a test with the chicken had gone against him. Secondly, a man accused by a woman of having committed adultery with her could demand that both should drink the poison. And thirdly, the poison was occasionally given to small boy captives in cases involving princes.

Other Ordeal Poisons

As evidence of the importance of the genus *Strychnos* in the ordeals of the Congo and Gabon, there are two other species, *S. Kipapa* Gilg of the Mukenge region, and *S. dekindtiana* Gilg of the Congo and Angola, which were used in a fashion similar to *S. Icaja*.

The drink was prepared by placing the powdered bark of the roots in a gourd or cup with some straw. Water was then added, and the mixture was stirred. The liquid, which had become red, was strained and stored until needed.

Its effects were essentially the same as those of *S.*

Icaja. Either vomiting or death preceded by convulsions was the result.

Although *Strophanthus hispidus* A. P. DC. of the *Apocynaceae* grew in many of the western countries, as well as in the Congo and Gabon, it was used primarily as an ordeal only in the latter regions. It was the *inée* or *onage* of the Gabon natives.

The poison in this plant was contained in the seeds, which were ground up and added to water, the resulting decoction being fed to the accused person.

Its active principles, the cardiac glycosides strophanthin and ouabain produced effects somewhat similar to a combination of digitalis and curare. There was an introductory irregularity of the heart and respiration followed by a gradual slowing of both until the heart finally failed. Convulsions immediately before death were frequent.

Although *Securidaca longipedunculata* Fres. of the *Polygalaceae* grew in most of the western and coastal countries, it was used as an ordeal poison primarily in the Congo.

The active principles are methyl salicylate ($C_8H_8O_3$) and a saponin. They cause damage to the bone marrow and engender haemolysis in the blood.

The general effects on the person were similar to the action of other ordeal poisons, except for the fact that certain people were more highly susceptible to it than others. This factor was undoubtedly highly influential in its retention as an ordeal poison.

Present-day natives of the same area have established an interesting link with the days when this poison was in constant use. They now give it to persons possessed of evil spirits to cause the vomiting and purging which supposedly drives those spirits from the body.

Several other plants which found use in the Congo as ordeal poisons are *Combretum confertum* Laws. of the

Combretaceae, *Piptadenia africana* Hook.f. of the *Leguminosae*, mushrooms from the genus *Dictyophallus* of the family *Phallaceae*, and *Manihot esculenta* Crantz of the *Euphorbiaceae*. This last plant, as previously mentioned, was used to a certain extent all over Africa, but its greatest popularity was in the Congo.

Its seeds contain the alkaloid manihotoxine (structure and composition unknown), which causes violent vomiting, burning of the throat, and acute diarrhea. In large doses it is fatal. The juice of its roots was also employed as an ordeal poison. The active principle therein is hydrocyanic acid, which acts by forming a stable complex with hemoglobin and by inhibiting the action of cytochrome oxidase.

Two additional poisons of the Congo were not taken internally. These ordeals were called *epomi* and *mokungu*. The plants employed were numerous members of the genus *Acacia* of the family *Leguminosae*.

In these ordeals, the sap pressed from the bark was put under an eyelid of the accused person, or under the eyelids of both disputants in a civil case. If the eye were destroyed, the charge against that person had been valid. This type of ordeal was usually reserved for women, especially among the Ngombe of the Northern Congo.

West Africa

The ordeal poisons of West Africa were generally employed in the same fashion as those of the central region. They differed only in that there was a greater geographical distribution both of the plants involved and of the employment of their poisons.

Since most of the poisons that were used in the extreme west were also known and employed in the northern areas of French Equatorial Africa and the Cameroons, these countries will be considered with the West.

Erythrophleum guineense G. Don

Erythrophleum guineense G. Don. of the *Leguminosae* was one of the most widely used ordeal poisons in Africa. This species has also been designated by the following synonymy: *E. judiciale* Proctor, *E. ordale* Bolle, *E. leonense* G. Don, *Mavia judicialis* Bertol., and *Afzelia grandis* Hort. ex Loud. In addition to having its greatest concentration on the western coast from Senegal to the Cameroons, it was often resorted to in the Congo and Gabon, and found occasional use in the eastern and southern regions. Its vernacular names, each of which was used in several different regions, were sassy bark, *moavi*, *n'kasa*, *n'ka*, *mancona*, *arui*, *m'bondo*, *casca*, *cassa*, *teli*, *tali*, *meli*, and *bouronne*.

The bark of this large tree, which varies in height from 40 to 100 feet, contains the extremely toxic alkaloid, erythrophlein. This alkaloid effects the heart and body in a manner similar to digitalis and picrotoxine combined, i.e., it causes an abolition of voluntary motion, exaggeration of reflex action, and convulsions followed by paralysis of the heart. Its external effects are a paling of the face, labored and irregular respiration, convulsions, vomiting of watery material without effort, urination and fecal discharges, several great convulsions, and then death.

In addition to the effects of the poisonous principles, it has been suggested that tannins contained in the bark were largely responsible for the tree's employment as an ordeal poison. Since these substances are highly irritative to the lining of the stomach, more often than not the poison was probably rejected before its poisonous action had commenced. A poison which invariably killed would undoubtedly have had a short life as a vehicle for the ordeal.

Preparation of the poison was often simple. The bark

(or sometimes leaves and seeds) was merely scraped and powdered, added to water, and allowed to steep. Sometimes the person was only given the bark to chew, followed by a large draught of water. However, in many cases, there were certain additions to the brew which made the procedure extremely complicated. A simple addition consisted of salt to enhance the poisonous effects. But more often, the extra material was made up of powdered glass, lizards, toads, crushed snakes, and human flesh. The hearts of the previous year's victims were dried in the sun, powdered, and mixed with the succeeding year's brew. This mixture, which might additionally have contained human brains, liver, blood, and bile, was put into a vat or tub and allowed to infuse and ferment for a year. When it was needed, two spoonfuls were added to a cup of water and mixed.

This practice seems to have been especially common among the Balantes, for it was their tribe which held human skin to be particularly significant. As in Madagascar, the natives believed that spirits of evil subsisted on human flesh. Similarly, it was thought possible for a person's body to become host to one of these spirits, who had come to torment the community, whether or not the individual was cognizant of the spirit's presence. Thus, when undergoing the ordeal, if the pieces of skin were not found among the egested material, the person was declared guilty, for the evidence that he was harboring an evil spirit seemed incontrovertible.

Among the majority of the tribes which employed this poison, preparations and all aspects of the procedure were carried out in public to demonstrate that no trickery was involved. To substantiate this further, a sample from each batch of poison was given to dogs before the ordeal. When the dogs were dead, proceedings commenced.

In one tribe, the accused was seated on a high seat in

the center of a circle. The medicine man raised one hand in the air, and placed the other on the jaw of the participant. He then showed the bark to the crowd, washed it with his own hands, and grated it into water. Before the accused was allowed to drink, he was compelled to spit and to rinse his mouth to demonstrate his good faith by having nothing hidden. He was then fed rice or cola, and was carefully watched as he repeated a prayer of imprecation against himself as if he were guilty. Finally, he was allowed to drink. As soon as he had emptied the cup, it was refilled. There existed no set number of cups. Hence, it was filled over and over, even after he had started to vomit. This was continued until he had given up all the material he had been fed, for this was the sign of innocence. If he egested some, but not all, of the food, he was sometimes allowed to retire. If the poison had not acted as a purge by that hour the next day, he was pronounced innocent. During the trial, if the accused did not vomit, or was purged, he was deemed guilty. (Perrot and Vogt, 1913)

In one tribe of Cazamance, sixteen cups of poison was the maximum limit. If the victim consumed all of them without event, he was declared guilty. When this had been established, the medicine men would try to induce vomiting by feeding him raw eggs. In the event that these efforts failed and the person died, or if he were too old to be sold as a slave, one of his relatives was taken instead, unless his family was rich enough to buy his freedom. When the accused did vomit during administration, he was required to move his arms and legs to demonstrate their suppleness before he was pronounced innocent.

In addition to the normal use of the ordeal, aspiring witch doctors had to submit to it several times as one of their final tests. Kings, too, were occasionally subjected

to it. When a king died from an hereditary throne, at least one of his sons must have submitted twice, must have been willing to undergo the trial for a third time, and must have given proof of his power as a great witch doctor, or the throne was declared vacant. In the rare case in which an enthroned king was called to submit, he was usually allowed to take the poison by proxy, i.e., a slave was sent instead.

Before the occupation by the French, almost all of the villages of Cazamance and the Balantes held mass ordeals each year to purge their societies of any sorcerers or criminals. To participate in, and to triumph over, the ordeal was a matter of great social prestige. Even those who had left the country tried to return to join their families in the ceremonies. Their faith was so great that, if a person tried to escape the ordeal, he was caught, deprived of his belongings, forced to leave the country, and branded a public disgrace for the rest of his life.

In order to participate, it was necessary to pay a certain fee, which was usually beyond the means of the average native. Their faith in the ordeal, however, prompted the poor to go to work for the whites of the area, until they had the requisite amount. Other forms of payment might be rice, silk, loincloths, or some other commodity. A middle-class person would often give a nanny-goat, and a wealthy native would bring a bull as his gift. In modern days, before the ordeal was outlawed, the privilege to participate cost three francs.

This payment had to be made to the medicine man before the ceremonies. For this type of ordeal, that person was usually of the Diola race, and was brought to the village especially for the ceremony. The pay was split three ways: one-third went to the medicine man who officiated; one-third was given to the village chief; and one-third was sent to the chief of a village totally

unconnected with either the Balantes or the Diolas. There seems to be no explanation for this last action.

The day of the ordeal was a festive holiday. People sang and feasts were prepared by those who expected to triumph over the trial. The ceremony was conducted in a clearing away from the village, where the people formed a wide circle around the medicine man who distributed the poison in cups.

As soon as he drank the *tali*, each Balante ran to the bushes and seated himself at the foot of a tree. Those who were saved soon vomited, and returned to the village with the rest of those who had survived, each convinced that this was the end of trouble for their community. But those who died were hated and blamed for all evil. Their bodies were thrown into the underbrush to rot or to be eaten by wild animals.

The mortality rate of these ordeals was exceedingly high. Each year approximately one-fourth of the population succumbed. In 1895, the French made the practice a crime. But nevertheless, in 1910 and 1911, there were respectively 1,500 and 2,000 deaths. At the present time, however, it is doubtful that even the most isolated natives practice this custom. (Lasnet and Boyé, 1911)

In the Boriawah tribe, the medicine man held a lizard in his hand when there had been suspicion of witchcraft. As he walked among the people, the lizard occasionally jumped on a person, who was then considered to be under suspicion and was forced to submit to the ordeal.

If the crime were a serious one, and if all concerned were certain of the person's guilt, cup after cup of poison was pressed upon him until he died or confessed, thinking that a judgement had fallen upon him. (Strong, 1911)

In the western part of the Congo, the bark was gathered by a medicine man who mixed the poison to a paste

by maceration with water. If he wished to kill his victim outright, he would mix with the paste one of the *Strychnos* barks (probably *S. Icaja*). The accused man was made to stand on a stone or a marked spot, and was not allowed to move from it during the ordeal. All the inhabitants turned out for the occasion, the girls with their skin painted, and the young men with their showiest ornaments. Dancing and singing accompanied the trial. The proclamation of guilt was the act of purging or vomiting.

In the same area of the Congo, a different procedure existed. The poison bark was finely ground and mixed to a paste from which five small loaves were made. These were fed to the defendant over a period of fifteen minutes, while the onlookers called upon *Moloki*, the evil spirit, to come out. If death or vomiting resulted, the man was judged, respectively, guilty or innocent. If purging occurred, he was declared guilty, and was given a chicken to eat and enough palm wine to intoxicate him. He was then buried alive to prevent the evil spirit from escaping from his body with his last breath. A large fire was kept burning over the grave for three days, after which time the body was exhumed and eaten. An innocent man, however, was carried around the village and decorated with beads, while his accuser paid a pig as a fine. (Torday, 1913)

Among these people, there was one alternative to submitting to the ordeal. The person could swear innocence by *m'bondo*. If he were perjuring himself, it was believed that he would die of dysentery within several days. (Johnston, 1908)

It may be mentioned in passing that the majority of the natives of West Africa believed so implicitly in the justice of the ordeal that if an innocent man should succumb to the effects of the poison, he would usually not

maintain his statement of innocence. Instead, he would believe that his judgement had come because of some act that he had forgotten or because of a crime of which he was unwittingly guilty.

Abrus precatorius L.

Another poisonous species which was used in the west from Senegal to Nigeria was *Abrus precatorius* L. of the *Leguminosae*. This plant, which is also known as jequirity or Indian licorice, has hard, bright scarlet seeds which contain the tetanic glycoside, abric acid, and a toxalbumin, abrin.

Although the use of this plant as an ordeal poison was widespread, there were certain hindrances to its continued popularity as anything more than an accessory instrument. One drawback was that it possessed the characteristic toxalbumin latent period before the commencement of effects. This was due to its partial inactivation by gastric juices, resulting in slow absorption. (It is approximately 100 times less toxic when taken orally than when it is administered subcutaneously.) Secondly, gastric juices failed to act upon the seed coat, so care had to be taken that each participant chewed vigorously. But the greatest drawback was that immunity could be established by the repeated ingestion of small doses. This last factor is undoubtedly the reason for its somewhat restricted use even as an accessory poison.

During the ordeal, the accused underwent severe vomiting, purging, general weakness, an inability to stand up, cold perspiration, colic, a depressed and then accelerated heartbeat, trembling, and, finally, heart failure. The interpretation of these results was similar to the general rule.

Adenium Honghel DC.

Adenium Honghel DC. of the *Apocynaceae* is a shrub

whose growth and use as an ordeal poison were restricted to the French Sudan and the upper parts of Senegal, where it was used primarily by the Marabout tribe.

This plant, which was known in the vernacular as *bouron*, *hongkel*, *kaurane*, or *kidi-sarane*, contains an extremely powerful glycoside, adeniine ($C_{19}H_{28}O_8$). Its action is analagous to digitalis and ouabain in paralyzing the heart and affecting the medulla. The muscles and nerves remain excited even after death, and lose this property very slowly.

In preparation, the flowers and peduncles were pulverized and infused with water. The solid material was then removed. Shortly after drinking, the heartbeat and the blood pressure increased. Respiration became labored and spasmodic. Accompanying the rise of the respiratory irregularity was a similar irregularity of the heartbeats. When both reached a peak, they suddenly ceased simultaneously. *Post mortem* examinations revealed severe gastro-intestinal irritation.

Closely related to this poison was *Adenium somalense* DC., which grew only in those areas of the Sudan which were confined to the Sahara Desert. The Somali tribe used the expressed juice of this plant in their ordeals.

Detarium senegalense Gmel.

Detarium senegalense Gmel. of the *Leguminosae* occurs throughout West Africa, and was known by the natives generally as *niey datah* or *datah i ney* and specifically as *tali* (for the plant), and *meli* (for the bark). An interesting interrelationship exists in this terminology, for it is identical to that used for *Erythrophleum guineense*. It is possible, however, that the passage of time brought these words into general usage for the designation of many plants which were used for the ordeal.

According to custom, the bark was made into an in-

fusion with water. This brew was drunk by the accused, who would not die from a small dose. In larger concentrations, however, its active principle, which is unrecorded, brought swift death preceded by convulsions. The ceremonies connected with the use of this plant did not diverge from the pattern of the normal West African ordeals.

Elaeophorbia drupifera Stapf

Another little-used plant was *Elaeophorbia drupifera* Stapf of the *Euphorbiaceae*, which grew abundantly throughout the west, but seems to have been used as an ordeal poison only in the Ivory Coast region. It was colloquially known as *do*, *douo*, *tene*, *dohe*, *klatou*, *baga*, *faman*, *and gbo*. Its active principle, whose name and chemical classification are unrecorded, was contained in the caustic white latex of the plant. This material was expressed and mixed with water. The usual methods of its use paralled those of *Erythrophleum guineense*. However, among certain tribes of the Ivory Coast, the latex was spread on the eyes of the accused, and was rubbed in with the fingers and several wisps of cotton, which were left there. The judgement of effects was similar to the judgement of its counterpart in the Congo. Damage to the cornea was evidence of guilt.

Mimusops Djave Engl.

Mimusops Djave Engl. (*Bassia toxisperma* Raoul) of the *Sapotaceae* is a giant tree of the evergreen forests of Nigeria and the Cameroons. Its use as an ordeal poison, however, was restricted to the latter region, where it was known by the natives as *noumgou*. The mahogany-colored nuts of the tree were used in the trials, for they contained a powerful cyanogenetic glucoside. Its employment in the ceremonies of the ordeal paralleled that of *Erythrophleum guineense*.

Physostigma venenosum Balf.

The best known ordeal poison of the western part of Africa, was the famous Ordeal Bean of Calabar, *Physostigma venenosum* Balf. of the *Leguminosae*. This tall, woody vine grew to an approximate length of 15 meters and a width of 5 centimeters at the base. Its habitat was the swampy areas from Sierra Leone to the Cameroons, and especially the Calabar Coast near the Gulf of Guinea at the mouth of the Niger River. The vernacular names of this plant were *isho*, *esere*, and *djirou*. In Gabon it was known as *n'chogo* or *m'boundou*, and in the Pahouin tribe as *itounda*, although it was rare in these areas.

Its active principles, the properties of which are antidotal to strychnine and atropine (and are used by the present-day natives in this capacity), are the alkaloids physostigmine (or eserine), calabarine, and eseridine (or geneserine). The most important principle, physostigmine ($C_{15}H_{21}N_3O_2$), acted as a powerful sedative of the spinal cord, resulting in a progressive and ascending paralysis of the lower limbs, a loss of voluntary muscular control, the paralysis of the smooth muscles of respiration, and death by asphyxiation. It acted on the involuntary muscles in a way resembling pilocarpine, i.e., there was an ascending and progressive tetanic contraction of the smooth muscles of the alimentary tract.

Its action was contradictory in that it paralyzed the motor nerve centers but stimulated the nerve endings. However, in highly poisonous doses, the central effect overcame the peripheral. Further action was illustrated by an acute increase in the volume of the blood and in the number of red corpuscles. This was probably due to the stimulation of the smooth muscles which expressed blood from stagnant areas.

The two less important principles, calabarine (compo-

sition unknown) and eseridine ($C_{15}H_{21}N_3O_3$), are thought to be decomposition products of physostigmine, which is relatively unstable. Calabarine, however, is antagonistic to physostigmine, but is usually present in such small quantity that its effects are negligible. In older beans, on the other hand, this principle might well, as a result of decomposition, have been present in large quantities. It stimulates the spinal cord in a manner similar to strychnine. Eseridine is essentially a purgative agent.

The following is an account of the observed effects of a fatal dose: (Balfour, 1860) Until about ten minutes after ingestion, the individual felt no ill effects. At that moment, however, he began to get thirsty, and experienced severe stomach cramps which the ceremony of the ordeal decreed he should bear without showing his pain. This progressive thirst was accompanied by an increasing flushing and swelling of the face which caused the victim to assume a stupid, drunken look. Then followed a protrusion of the eyes, trembling, and heavy salivation, which eventually became frothy. An intense contraction of the pupils of the eyes, heavy bowel movements, and increased difficulty in breathing accompanied this stage. As the limbs began to lose their usefulness, the person walked as if drunk. Soon, however, he lost the power to stand. This paralysis spread from the lower extremities upwards until the victim was in a general state of paralysis. Shortly after this, the poison reached the medulla, and with the incapacitation of the respiratory organs and the cardiac musculature, the person died. This resulted usually about thirty minutes after the ingestion of the beans. It is interesting to note that, up until the last stages of paralysis, reflex actions were still intact and the victim was able to converse coherently and sensibly.

Conversely, a judgement of innocence came from the following reactions. The accused experienced nausea and

vomiting, but no lasting effects other than a headache which normally lasted for several hours after the test.

There were a number of variable factors which influenced the outcome of each ordeal. Primary among these was the inherent physical condition of each participant. If his digestive system were sensitive, the poison immediately irritated it to the point of causing him to vomit, thus saving him. However, if he were strong, robust, and had a good digestion, the poison probably was retained, bringing death. Even if this unfortunate did recover, the negative verdict of the ordeal was sufficient to warrant a sentence of death in some other fashion. An equally important factor in determining the outcome of the test was the degree of corruption of the medicine man in charge. It was possible for him to influence the results in a number of ways, such as regulating the number of beans, using the more poisonous mature beans, or altering the method of preparation to increase the concentration and hence the toxicity of the poison. However, as might not be expected, a large number of beans was not necessarily more toxic than a smaller number, for the greater amount of poison would usually irritate the lining of the stomach and cause rejection of the poison before it had reached a fatal concentration in the blood. The maximum number of beans which have been eaten without fatality in a single ordeal is listed as 35. Often, if the witch doctor were the accuser, both he and the accused had to take the test.

The ordeal by Calabar Bean, in addition to being used on criminals and sorcerers, was often given to warriors to test their fitness, and to children to see if they were going to grow up into virtuous, brave, and capable people.

The bean was administered either in the natural state or as an infusion in water. Boiling this water decreased the toxicity.

The methods of trial varied from area to area. In one tribe, it was customary to hold mass ordeals when the king died. In another, the number of beans which were egested was augmented by a similar number which the subject was required to eat. This augmentation continued until death occurred, or until all the beans in his stomach were rejected at one time.

In a third area, the judges, who were the chiefs of the village, would put the beans on the ground in front of the accused, who had to pick them up one by one and eat them. It was in this tribe that the medicine man was thought to influence a result of death by rubbing the beans with the tail of a leopard.

Contrary to the strong faith existing in other tribes, the natives of the Calabar region had no consistent beliefs about this practice. In one region, the ordeal was approached with confidence, while in another, it was looked upon as a sentence of death. Rarely would an individual publicly demand to submit, a common occurrence among other tribes. When this did happen, however, it was usually assumed that the person had made previous arrangements with the poison preparer.

For some years, it was highly difficult for investigators to obtain specimens of the plant for botanical classification, for although the natives were well acquainted with the bean itself, they knew nothing of its origin. This situation was in existence because, as written by the Rev. H. M. Waddell of Calabar (Hanbury, 1876),

> The plant is everywhere destroyed by order of the king, except when it is preserved for supplying the wants of justice — and that the only store of seeds is in the king's custody.

This practice resulted in a near deification of the plant, and was continued until the middle of the 19th century, when the practice of the ordeal was outlawed. This edict

was not immediately obeyed, but observance in any but the deepest areas of the jungle was made virtually impossible. It is now believed, however, that the practice has been completely effaced.

Conclusion

In order to appreciate the full significance of the ordeal in the minds and lives of these primitive people, it would be necessary to live in intimate contact with them. Although this is rarely feasible, a certain understanding may be gained by viewing the situation psychologically.

Consider the native in relation to his spiritual beliefs. Most of his life was spent under the pall of uncertainty and fear concerning the evil spirit who inhabited his whole universe. His mind was ruled by the thought of what their malign influence could do to him or to his family. When viewed in this light, the ordeal was a godsend for him in the simplicity and efficacy of its action. No longer did he feel that he had no defense against these mysterious powers.

When considered from a purely material viewpoint, his secular life was also immeasurably strengthened in security. Here was his defense against any wrong done to him. Here was a swift and simple method for determining the truth of a situation. It mattered little to him that, occasionally, a person he knew was innocent would be declared guilty, for his faith told him that both he and that person had been ignorant of the other's unconscious sin.

Naturally, the basic fallacy of his beliefs are evident when considered today. But even here the situation is not completely implausible. For, although psychosomatic interrelationships as yet constitute a little-explored field, it is common knowledge that this relationship exists, and that in certain cases it may exercise a definitely

positive influence over a person's reactions to various stimuli. We cannot state incontrovertibly that the power of an innocent native's faith did not occasionally cause his stomach to reject the poison. Nor could we be sure a guilty party did not realize that, according to his deepest beliefs, he would not be able to rid his stomach of the poison.

However, our purpose has not been to determine the inherent good or evil in this practice, but merely to illustrate the numerous variations in method, observation, and interpretation which were found throughout the area, and to demonstrate the illimitable value of this ordeal by poison in the complicated spiritual and secular life of the African native.

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